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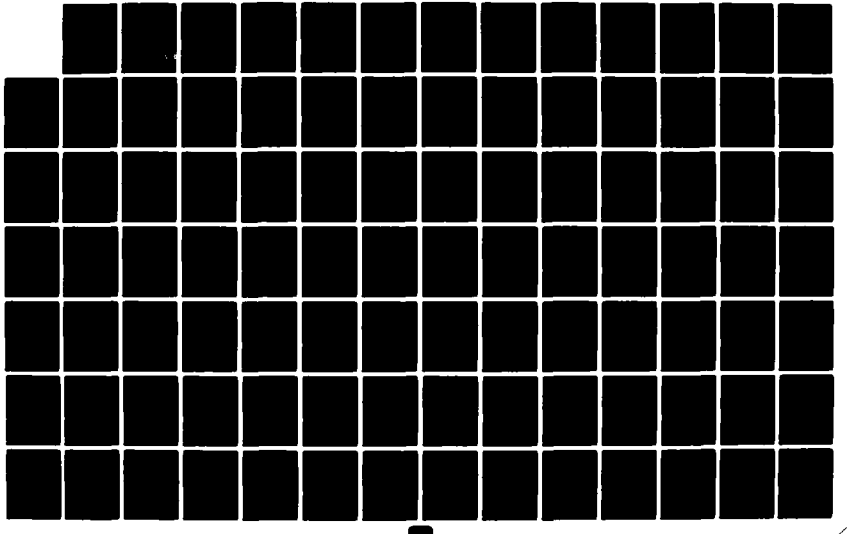

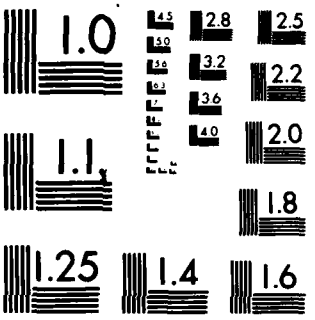

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MISSOURI RIVER ENVIRONMENTAL INVENTORY

FINAL REPORT
1973

"MEASUREMENTS OF THE SPECIES DIVERSITY OF PLANTONIC AND MICROBENTHIC ORGANISMS"

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TABLE OF CONTENTS

	Page
LIST OF TABLES	1
PURPOSE OF THE INVESTIGATION	7
INTRODUCTION	8
METHODS AND MATERIALS	11
Millipore Filtering Procedures for Surface Water Samples	14
Millipore Filtering Procedures for Benthos Samples	15
Method for Determining the total Numbers of Organisms Per Unit Area of Benthos habitat	16
Formula for Determination of the Total Number of Surface Water Organisms Per 1.0 ml of Surface Water	21
RESULTS AND DISCUSSION	
Physical and Chemical Conditions	22
Discussion on the Organisms Identified In the Missouri River and In Synder Bend and DeSoto Bend Oxbow Lakes	36
Aufwuch Organisms	43
SUMMARY AND CONCLUSIONS	107
BIBLIOGRAPHY	112
APPENDIX	116

Table		Page
29.	The five most abundant diatom genera in the benthos samples collected during November, 1972	66
30.	The five most abundant diatom genera in the plankton samples collected during November, 1972	67
31.	The two most abundant species of ciliates and flagellates in the benthos samples collected during November, 1972	68
32.	The two most abundant species of ciliates and flagellates in the plankton samples collected during November, 1972	69
33.	The five most abundant diatom genera in the benthos samples collected during February, 1973	70
34.	The five most abundant diatom genera in the plankton samples collected during February, 1973	71
35.	The two most abundant species of ciliates and flagellates in the benthos samples collected during February, 1973	72
36.	The two most abundant species of ciliates and flagellates in the plankton samples collected during February, 1973	73
37.	The five most abundant diatom genera in the benthos samples collected during March, 1973	74
38.	The five most abundant diatom genera in the plankton samples collected during March, 1973	75
39.	The two most abundant species of ciliates and flagellates in the benthos samples collected during March, 1973	76
40.	The two most abundant species of ciliates and flagellates in the plankton samples collected during March, 1973	77
41.	The five most abundant diatom genera in the benthos and plankton samples collected from the oxbow lakes during March, 1973	78
42.	The two most abundant species of ciliates and flagellates in the benthos samples from the oxbow lakes collected during March, 1973	79

Table		Page
43.	The two most abundant species of ciliates and flagellates in the plankton samples from the oxbow lakes collected during March, 1973	80
44.	The five most abundant diatom genera in the benthos samples collected during April, 1972	81
45.	The five most abundant diatom genera in the plankton samples collected during April, 1973	82
46.	The two most abundant species of ciliates and flagellates in the benthos samples collected during April, 1973	83
47.	The two most abundant species of ciliates and flagellates in the plankton samples collected during April, 1973	84
48.	The five most abundant diatom genera in the benthos and plankton samples collected from the oxbow lakes during April, 1973	85
49.	The two most abundant species of ciliates and flagellates in the benthos and plankton samples collected from the Oxbow lakes during April, 1973	86
50.	The five most abundant diatom genera in the benthos samples collected during May, 1973	87
51.	The five most abundant diatom genera in the plankton samples collected during May, 1973	88
52.	The two most abundant species of ciliates and flagellates in the benthos samples collected during May, 1973	89
53.	The two most abundant species of ciliates and flagellates in the plankton samples collected during May, 1973	90
54.	The five most abundant diatom genera in the benthos and plankton samples from the oxbow lakes collected during May, 1973	91
55.	The two most abundant species of ciliates and flagellates in the benthos and plankton samples from the oxbow lakes during May, 1973	92
56.	The five most abundant diatom genera in the benthos samples collected during June, 1973	93

Table		Page
57.	The five most abundant diatom genera in the plankton samples collected during June, 1973 . . .	94
58.	The two most abundant species of ciliates and flagellates in the benthos samples collected during June, 1973	95
59.	The two most abundant species of ciliates and flagellates in the plankton samples collected during June, 1973	96
60.	The five most abundant diatom genera in the benthos and plankton samples from the oxbow lakes collected during June, 1973	97
61.	The two most abundant species of ciliates and flagellates in the benthos and plankton samples from the oxbow lakes collected during June, 1973 .	98
62.	The five most abundant diatom genera in the benthos samples collected during August, 1973 . .	99
63.	The five most abundant diatom genera in the plankton samples collected during August, 1973 . .	100
64.	The two most abundant species of ciliates and flagellates in the benthos samples collected during August, 1973	101
65.	The two most abundant species of ciliates and flagellates in the plankton samples collected during August, 1973	102
66.	The five most abundant diatom genera in the benthos samples from the oxbow lakes collected during August, 1973	103
67.	The five most abundant diatom genera in the plankton samples from the oxbow lakes collected during August, 1973	104
68.	The two most abundant species of ciliates and flagellates in the benthos samples from the oxbow lakes collected during August, 1973	105
69.	The two most abundant species of ciliates and flagellates in the plankton samples from the oxbow lakes collected during August, 1973	106

Page

A. (Appendix) Formula for Planktonic Algae Fixative Stain 116

B. (Appendix) Formula for Schaudinn's Fixative 117

C. (Appendix) Dissolved Oxygen -- Titration Method Using PAO 118

D. (Appendix) A hypothetical example to explain the method used for determining the total number of organisms per unit area of benthos habitat 119

E. (Appendix) A hypothetical example to explain the formula for the determination of the total number of planktonic organisms per 1 ml of surface water. . 120

I. PURPOSE OF THE INVESTIGATION

The purpose of this investigation was to prepare an environmental inventory and assessment report dealing with the Missouri River and its associated floodplain lands from Yankton, South Dakota to Rulo, Nebraska. This study of the inventory was concerned with the Missouri River and its associated riparian habitats within one mile of the present Missouri River channel. Major benthic habitat areas studied include areas adjacent to channel and bank stabilization structures, oxbow lakes, chutes, main channel, backups, riverside marsh and confluence of tributary streams.

An important part of this review is an inventory of existing environmental conditions along the river that would harbor planktonic and microbenthic organisms. Major reasons for the study include: (1) The compliance with recent national and Corps of Engineer objectives dealing with the maintenance and enhancement of environmental quality in conjunction with Federal water resources development activities; (2) Collection of basic natural resources information needed to prepare an adequate operations and maintenance environmental impact statement for the Missouri River Navigation-Bank Stabilization Project; (3) Compilation of existing research concerning fish and wildlife, natural vegetation and recreational use along the river which can be used in conjunction with the existing Corps project to more adequately develop the existing fish and wildlife, and recreational potential of the river and (4) To complement another Omaha District Corps of Engineer's study involving remote sensing of the river and its associated lands.

The planktonic and microbenthic organisms are often ignored as a major group in the flora and fauna that inhabit the environment of the Missouri River. However, the importance of the planktonic and microbenthic members should not be judged simply on size alone. The diatom, protozoan, and metazoan species represent a significant biomass inhabiting the Missouri River. Other researchers (Morris, 1965 and Moode, 1973) report the importance of planktonic and benthic organisms as fish food. The diatoms and protozoan forms represent an important part of the overall food chain and nutrient cycles in the Missouri River. The diatoms are eaten by many larger protozoan forms which are eaten in turn by larger benthic forms. The larger benthic forms are food for non-predatory species of fish which in turn are food for the predator fish.

II. INTRODUCTION

The contents of this final report involves an environmental inventory study project which was begun in June, 1972 and with the aid of a two month continuance granted in July, 1972, will terminate on October 1, 1973.

This project involved identification of planktonic and benthic organisms, the species diversity, relative abundance and factors limiting micro-and macroscopic organisms presently occupying various water, mud/water and rock substrate habitat sites in the channelized and unchannelized portions of the Missouri River from Yankton, South Dakota to Rulo, Nebraska. Also included in this study are the measurement and description of physical and chemical water quality parameters that are critical to the survival of micro-and macrobenthic groups, and the association of particular benthic groups to major habitat areas found in the river. Water quality parameters include temperature, temperature profiles, dissolved oxygen, turbidity, biological oxygen demand, pH, nitrate (NO_3) content, PO_4 (ortho and meta phosphate) content, sedimentation rates, and water velocity. Air temperature was another important parameter because the water temperature is largely dependent upon the temperature of the air.

III. SAMPLING STATIONS

Because of the great distances involved during this inventory project, we have divided the Missouri River from Yankton, South Dakota to Rulo, Nebraska into four sections of study which are as follows: 1) Yankton, South Dakota to Sioux City, Iowa; 2) Sioux City, Iowa to Blair, Nebraska; 3) Blair, Nebraska to Nebraska City, Nebraska; and 4) Nebraska City, Nebraska to Rulo, Nebraska. Twenty-one sampling stations were established scattered throughout the four mentioned sections for collecting purposes. There are eight collection stations in Section 1, four stations in both Sections 2 and 3, and five stations in Section 4. Extra stations were selected in Section 1 because the unchannelized portion of the Missouri River offered greater variety in both species habitat and diversification.

The following is a list of the sampling stations used for this project. In each case the Section number (1, 2, 3, or 4) in which the sampling station is located, the station number, the description of the station, and the Missouri River Channel Mile; based on 1960 channel mileage, for each station is listed (see table 1). All of the sampling stations in Section 1 are in the unchannelized portion of the Missouri River study project. All of the stations in sections 2, 3, and 4 are in the channelized portion of the Missouri River study project.

TABLE 1 SAMPLING STATIONS

Section	Station Number	Description of Sampling Station	River Mile
1	1	Tailwaters of Gavins Point Dam	811.0
1	2	First backup west of Bow Creek, Nebraska on the Nebraska side of the Missouri River	787.6
1	3	First chute on the downstream end of Goat Island on the Nebraska side of the Missouri River	782.5
2	4	The mouth of the Little Sioux River in Iowa	669.2
3	5	The mouth of the Platte River in Nebraska	594.8
4	6	Behind a rock pile dike on the Iowa side of the Missouri River	556.5
1	7	Second chute west of Bow Creek, Nebraska	788.0
1	8	Shallow sand-bar on the north side of Goat Island on the east end of the island	782.7
2	9	The mouth of the Big Sioux River in Iowa	734.4
2	10	A slough connected to the Missouri River on the Iowa side	724.5
4	11	Behind a rock pile dike on the Iowa side of the Missouri River	553.2
3	12	A cove on the Nebraska side of the Missouri River	564.5
4	13	Rulo, Nebraska Boat Club Landing	498.2
1	14	First backup on the east end of Goat Island on the Nebraska side of the Missouri River	783.0
1	15	Clay County Park, South Dakota boat landing	781.0

Section	Station Number	Description of Sampling Station	River Mile
1	16	The mouth of Bow Creek, Nebraska	787.5
2	17	Synder Bend Oxbow, Iowa	713.0
3	18	DeSoto Bend Oxbow, Nebraska	642.0
4	19	Brownville Marina at Brownville, Nebraska	535.0
4	20	Riverview Park at Nebraska City, Nebraska	563.3
3	21	Haworth Park at Bellevue, Nebraska	601.0

Sampling stations 1 through 14 were established during the summer and fall of 1972. In response to a request we sampled several suggested oxbow habitats in Section 2 and 3, station 17 at Synder Bend Oxbow in Iowa and Station 18 at DeSoto Bend Oxbow in Nebraska in February, 1973. Because of the low water conditions present in the Missouri River during the early spring months of 1973, several stations were added with the advantage of being easily accessible by car rather than by boat only. These stations were numbers 15, 16, and 19-21.

IV. METHODS AND MATERIALS

At each sampling station a surface plankton sample and a benthos sample were collected. Also a Hester-Dendy collecting device was set out for "Aufwuchs", (Ruttner, 1953) more commonly known as migratory aquatic organisms. The Hester-Dendy sampler was placed into the water and examined after two to three weeks. All collecting bottles and vials were labeled with the date, station number, and type of sample being collected for future identification and reference.

The surface plankton sample was collected by dipping a small glass vial just below the surface of the water. The vial was marked along the side at 10ml, 20ml, and 30ml amounts. The vial was allowed to fill with water and then was swished around to obtain a random sample. Thirty ml of the water was then poured into a 50ml plastic vial that contained 0.3ml of Planktonic Algae Fixative stain (IKI) (See Appendix). A plastic cap was placed onto the sample vial to prevent the contents from dehydrating.

The benthos sample was collected according to either of two methods. In the first method a round, cylindrical, plastic core device, which was marked along the side in 10ml divisions, was pushed down into the mud. Water is allowed to flow into the top. A size number 8 rubber cork is then placed on the top of the coring device to create a partial vacuum that allows the benthic core to be brought up to the surface without sliding back out the bottom. The cork is then loosened and the water and mud are let out slowly until only the top 10cm of bottom mud is left in the core. The 10cm of bottom mud together with 200ml of river water, some of which remains on top of the 10cm of mud in the plastic core, are poured into a large container where the contents are stirred vigorously and 10ml of the solution is taken out with a basting suction device (similar to that used for cooking purposes). The 10ml of mud/water interface is poured into a 50ml plastic vial that contains 10 ml of Schaudinn's Fixative. (See Appendix). A plastic cap is placed onto the vial to prevent

dehydration. This method of sampling the benthos community is only feasible in water depths of two to three feet because the core device is lowered to the bottom by hand.

The second method of sampling benthic communities is very similar to the first method in that it uses the same basic procedures. The only difference is that the core device is placed inside a brass alloy cylinder that can be attached to several sections of lead pipe and lowered to depths of twelve to thirteen feet. The core sampler is pushed into the mud and a triggering device is pulled by a length of nylon string which is attached to the metal coring device and is held in one hand by the operator. The nylon string is pulled and causes a small plunger to seal off the top of the coring device before it is brought to the surface and this keeps the core from falling out because of the partial vacuum created. The sample is then processed according to the methods described for the first benthic sampling method.

A Hester-Dendy sampler (see picture) is a collecting device for studying the rate of recolonization and concentration of migrating organisms. The sampler is made of tempered hardboard. It is cut into eight 3-inch squares which are separated by seven 1-inch squares. A hole was drilled into the center of all of the squares and they were then held in place by a one-fourth inch diameter threaded bolt with a loop at the top end where a rope can be attached. The sampler exposes slightly more than 1 square foot of surface area to which organisms can attach (Hester-Dendy, 1962). The samplers are simply tied to any object and left sitting in the water. The samplers were collected periodically; usually after two to three weeks time. They were than taken apart and each piece is scraped off with a sharp knife or razor blade into a container filled with 200ml of pre-filtered river water. After the sampler has been completely scraped, the 200ml of water is mixed thoroughly by stirring with a basting suction device. Next, 10ml of the thoroughly mixed sampler scrapings and river water is taken out with the suction device and put into a 50ml plastic vial containing 10ml of Schaudinn's Fixative. A plastic cap is placed on top of the vial to prevent dehydration.

At each sampling station water was also collected for chemical analysis in 300ml glass stoppered bottles. Water chemical analysis was accomplished in the laboratory with the use of the Hach Chemical Kit Colorimeter (Hach Chemical Company, Ames, Iowa). Tests for the presence of NO_3 (nitrate), PO_4 (phosphates, ortho and meta) and turbidity readings were run according to procedures outlined in the Hach Colorimeter Methods Manual, 6th edition. Reading the pH were accomplished with the aid of a Corning Model #7 pH meter.

Duplicate bottles of water were also collected at each sampling station for Biological Oxygen Demand analysis. Readings for BOD's were taken according to the Hach Chemical Company Water and Wastewater analysis procedures. This method is similar to the Standard Winkler Method except that it uses Phenylarsene Oxide (PAO) for the titration instead of the Sodium Thiosulfate solution that previously has been used. (See Appendix)

Readings were also taken on air temperature, water temperature, and dissolved oxygen. The water and air temperatures were taken with the use of a Fisher centigrade thermometer. Dissolved oxygen readings were taken with the use of a Model 54 YSI (Yellow Springs Instrument Company Oxygen Meter). The thermistor was also able to read water temperatures and was used as a check with the centigrade thermometer. While such water chemistry does not provide definitive evidence, it supplies general information about the environmental conditions under which the microbenthic and planktonic organisms were collected.

MILLIPORE FILTERING PROCEDURES

The technique for making permanently mounted slides of benthic and surface samples was derived largely by trial and error. An 8μ.(micron) pore size, white, plain 25mm (millimeter) diameter Millipore Corporation, Bedford, Mass. 01730 filter was used with a 1/6 hp air pump manufactured by E.H. Sargent and Company. The Sargent filtering pump was set at no more than three pounds per square inch (psi) of pressure in order not to damage delicate cell membranes. The millipore filtering techniques used for this project are outlined below.

The 8μ.size Millipore filter was used so that most species of organisms could not pass through the pores of the filter during the filtering process. This small size of filter paper gave rise to the problem of large sediment particles and organic material which was often present on the filter paper. This problem was solved by using small aliquots of the sample or by diluting the original sample with deionized water. When taking an aliquot of the sample with a pipette, the sample vial was tilted as horizontally in position as possible in order to stir the contents thoroughly and assure randomness.

SURFACE WATER SAMPLE FILTERING TECHNIQUE

1. Add several mls. of 30% ETOH (Ethanol) on top of the filter paper and suction some of this amount through. This step tends to saturate the filter paper and prevents wrinkles from appearing on the paper when the water sample is placed on it.

2. Add 1 ml., or desired amount, of thoroughly mixed sample with a 10ml pipette.

3. After starting the suction pump, add 3 ml of 30% ETOH, then add 3ml of 50% ETOH, then add 3ml of 70% ETOH, and finally add 3ml of 95% ETOH. When adding the alcohol in this step it is important to add the alcohol along the sides of the glass column to wash any organisms down into the filter paper.

4. Stop the suction pump and add 3mls more of 95% ETOH into the glass column. Put several drops of Eosin Fast Green stain into the glass column with the 3mls of 95% ETOH. Let this mixture stand for at least 15 seconds in order to allow the cell membranes time enough to absorb the stain.

5. Start the suction pump again and add 6-9mls of 95% ETOH to the glass column. Now add 6-9 mls of n-propyl alcohol. The n-propyl alcohol is the final saturating alcohol used in this technique. Finally, add 6-9 mls of xylene to the glass column. The xylene acts as a clearing agent on the filter.

6. Stop the suction pump. Take a plain glass slide and place several drops of Permount on the slide. Remove the Millipore filter paper from the filtering apparatus and place it on top of the Permount on the glass slide. Add several more drops of Permount on top of the filter paper. Place a round glass coverslip on top of the filter and add several drops of Permount to the coverslip to prevent the filter from drying out.

BENTHOS SAMPLE FILTERING TECHNIQUE

1. Repeat the procedures outlined for the surface water sample filtering technique. The only exception is that a 1 ml pipette should be used because of the smaller water sample amounts that are needed due to the larger amount of sediments and organic material usually present in the benthos water samples. The small pipette tends to exclude some of the larger forms.
2. If very large amounts of sediment and organic material are present, it may be necessary to dilute the fixed benthos sample. This is done so that the organisms present in the water sample are visible after the slide has been prepared. To dilute the benthos sample, take 9mls of deionized water and 1ml of the water sample. Mix the 10mls thoroughly and take out the desired amount. Continue the filtering process by following steps 1-6 as outlined for the surface water samples.

The above procedures have been found to provide a reasonably clear, permanent slide that was used for the benthic and surface counts of organisms. The permanent stained and fixed glass slide can be stored for future reference; or it can be photographed for black and white or colored pictures of specific organisms.

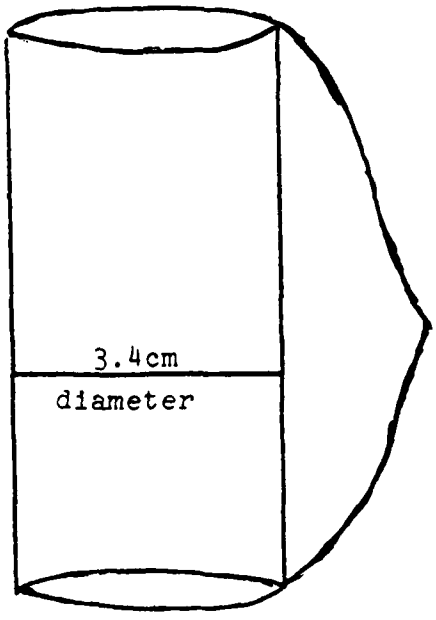
METHOD FOR DETERMINING THE TOTAL NUMBERS OF ORGANISMS PER UNIT AREA OF BENTHOS HABITAT

Throughout this project one of the main problems was the amount of organic material and sediments in the benthos sample vials. During preparation of the benthic sample for a permanent mount varying amounts of the sample were used depending largely upon the amount of organic and sedimentary material present in the sample vial, and upon the clearity of the permanently stained slide. Often times more than one slide from the same sampling station had to be made in order to obtain a stained preparation that contained enough organisms to establish a significant count and yet have the slide be free enough of debris to be accurately counted.

The benthic core samples were collected with a cylindrical plastic tube that was marked off in 10ml portions up to a total of 200ml. The exact method of collecting a benthos sample was discussed on page 11. An American Optical Micro Star microscope with a calibrated ocular grid was used to determine the area of the Millipore slide that was to be counted. By determining the total area of view on the slide it is then possible to establish a known area of the Millipore slide. If the area of the Millipore slide is known, a portion of the permanently fixed slide can then be counted, which will represent a percentage of the whole slide without having to count the entire slide. The total counts of the Millipore slides for the benthos samples were based upon a given area, (m^2) rather than a volume of river bottom habitat.

The procedures for determining the number of benthic organisms per square meter (m^2) and the multiplication factor for the Millipore slide transects is outlined on the following page.

Diagram of a plastic core device:



200ml volume

Radius = 1/2 of the diameter
Radius = 1.7cm (centimeters)

Area of a circle = πr^2
Area = $3.14\ (1.7cm)^2$
Area = $3.14\ (2.89cm^2)$
Area = $9.0746cm^2$

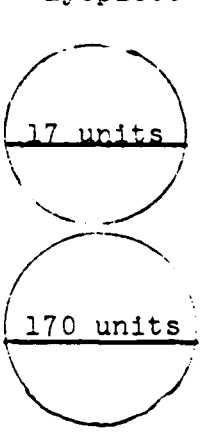
The area of the core sampler is $9.0746cm^2$.

The formula for the determination of the total number of benthic organisms per square meter of area is outlined below.

$$\frac{\text{NUMBER OF ORGANISMS COUNTED ON A MILLIPORE SLIDE}}{\frac{1}{17.3}\ (A)} \times \frac{10}{1}\ (B) \times \frac{2}{1}\ (C) \times \frac{200ml}{9.0746cm^2}\ (D) = \text{Number of Organisms/cm}^2 \times 10{,}000cm^2 = \text{Number of Organisms/m}^2$$

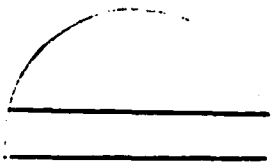
EXPLANATION OF THE ABOVE FORMULA

(A) - The total number of organisms of any particular species is multiplied by the transect counting factor which is 17.3. The transect counting factor is arrived at by the following steps.



A 10 unit ocular scale is placed in in one eyepiece and calibrated against a stage micrometer. Each unit of the ocular is equal to 106 μ using the 10X objective and 10X ocular. The field of view was found to be 170 units. Thus, 170 units X 106μ/unit at 10X magnification = 18,020μ = 18,02mm or 1.802 cm. The 18,020μ represents the diameter of the collected sample on the millipore slide.

Next, we multiply the diameter of the Millipore slide using a 10X ocular times the diameter of the 45X objective. field of 408μ. The μ (micron) units have been converted to centimeters. Thus, 1.8020cm X 0.0408cm = 0.0735cm^2.

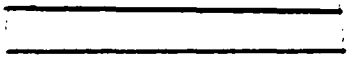


Since the Millipore filter paper is circular we need to know the area of a circle, which is πr^2. The diameter of the Millipore is 1.802cm. The radius is ½ of the diameter which gives us 0.901cm.

$$\frac{1.802}{2} = 0.901\text{cm. radius}$$

Area of a circle = πr^2
Area of a circle = $(3.14)\ (0.9\text{cm})^2$
Area of a circle = $(3.14)\ (0.81\text{cm}^2) = 2.54\text{cm}^2$

Thus, 2.54cm^2 is the area of one transect across the diameter of the Millipore slide.

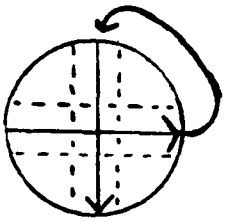


Thus, $\frac{2.54\text{cm}^2}{0.0735\text{cm}^2} = 34.6$

The number 34.6 is the multification factor. When one transect is counted across the millipore slide, we are counting only $\frac{1}{34.6}$ of the total area of the Millipore slide.

For this project usually two transects were counted on each slide to arrive at a reasonably random count because some organisms may have accumulated on certain areas of the Millipore slide and might be missed if only one transect was counted. In some instances the number of organisms in one transect count would be sufficiently high to only warrant the one transect count. These numbers would be multiplied by 34.6.

However, since most slides contained two transect counts, we must have a different multiplication factor. Thus, we multiply the number of cm^2 of a single transect rectangle time 2 to give us the number of cm^2 in two transects. We then divide this number into the area of the Millipore slide.



$$\frac{2.54cm^2}{(2)\ (0.0735cm^2)} = \frac{2.54cm^2}{0.147cm^2} =$$

17.27 or 17.3

Thus, the multiplication factor used when two transects are counted is 17.3.

(B) Part B of the formula deals with the different amounts of the benthos sample that were used to make a millipore slide. This number represents the number of organisms found in 1.0 ml of the benthos sample after it has been thoroughly mixed. For example, suppose we only used 0.1 ml of the benthos sample to make a millipore slide. We then must multiply the 0.1 ml X 10 to give us the number of organisms in 1.0 ml of the original sample.

(C) Part C represents another dilution factor which, unlike part B, will always remain the same number. We are now multiplying the number of organisms in 1.0 ml of benthos sample by 2, because the original cored sample was stirred up and 10 ml of it was placed into a plastic vial that contained 10 ml of Schaudinn's Fixative; hence the original sample was diluted by 1/2 and now has to be multiplied by 2.

(D) In this step we must multiply the number of organisms times a factor of 200 because this was the total volume collected in the original cored benthos sample. This will give us the total number of organisms in the 200 ml of the original cored benthos sample.

Since we want to know the total number of organisms per square meter (m^2) of benthos, we take the area of the core sampler and divide it into 200 ml. This result will give us the number of organisms per cm^2.

Thus, $\frac{\text{X organisms in original 200ml}}{9.0746 cm^2 \text{ (area of the core sample)}} = \text{number of organisms/cm}^2$

(E) Since we know the number of organisms per cm^2 of benthos as calculated in part D, we now must convert this figure into the number of organisms per square meter (m^2). To do this we multiply the number of organisms per cm^2 X 10,000 cm^2. This will give us the number of organisms per m^2 of benthos habitat.

Thus, number of organisms/cm^2 X 10,000 cm^2 = number of organisms/m^2 of benthos habitat.

A more simplified approach to the calculation of part E would be to take the area of the core sampler, which is 9.0746 cm^2, and divide it into 10,000 cm^2.

Thus, $9.0746 cm^2 \overline{)10{,}000 cm^2} = 1{,}101.97694$. By rounding 1,101.97694 to 1,102; we have a multiplication factor which can be used. Thus, we can take the number 1,102 in part E and multiply it times the unit volume in part D. This will give us the number of organisms per square meter (m^2) of benthos. The simplified approach will give us the same answer as if one followed the original formula. A hypothetical example is outlined in the appendix to explain how the formula works.

FORMULA FOR DETERMINATION OF THE TOTAL NUMBER OF SURFACE WATER ORGANISMS PER 1.0ml (MILLIMETER) OF SURFACE WATER

The determination of the numbers of organisms in the surface water is based upon a volume of water, rather than on an area which was used for the benthic samples. A surface water sample was collected according to the method described on page 14 of materials and methods. In the surface water samples we are concerned with the total number of organisms found in 1.0ml of water sample. The same microscope was used in counting the surface water samples as was used for the benthic samples. Since we are concerned with a volume of water rather than an area, we do not use the multiplication factor of the area of the benthic core sampler. Neither will we be concerned with any dilution factors for any fixative.

The formula used for determining the total number of organisms per 1.0ml of surface sample is as follows:

(A) Take the total number of organisms counted in two transect counts X 17.3 (B)

EXPLANATION OF THE FORMULA

(A) We add together the number of organisms counted in the two transect counts. Since we are concerned with the number of organisms in 1.0ml of water sample we may have to adjust the total counts so that they represent the number of organisms found in 1.0ml. For example, if 10ml of water sample was used in the Millipore filtering process, we would divide the total transect counts by a factor of 10 in order to arrive at the number of organisms/1.0ml. If the amount of water sample used in the Millipore filtering process was less than 1.0ml, then we have to multiply to total transect the total counts by the desired factor. For example, if only 0.2ml of the original water sample was filtered, then we multiply the total transect counts times a factor of 5 in order to arrive at the number of organisms in 1.0ml of water sample.

(B) In this step the total number of organisms counted in the two transect counts per 1.0ml of water sample is multiplied times 17.3. The number 17.3 is the multiplication factor used when two transects of the Millipore slide are counted. The multiplication factor is calculated according to the method outlined on page 19 of methods and materials. It is the same multiplication factor that was used for the benthic sample counts. A hypothetical example is presented in the Appendix to show how the formula works.

RESULTS AND DISCUSSION

PHYSICAL AND CHEMICAL CONDITIONS:

The purpose of this study was to identify the special features of the microhabitats of planktonic and microbenthic organisms within the unchannelized portion of the Missouri River from Yankton, South Dakota to Ponca, Nebraska; and the channelized portion from Ponca, Nebraska to Rulo, Nebraska. Water samples were collected periodically for chemical analysis from July, 1972 through August, 1973 in both the channelized and unchannelized portions of the study. Water samples were collected monthly from Snyder Bend and DeSoto Bend Oxbows from March to August, 1973. Because of the large volume of data collected, only two typical sampling stations in the unchannelized and in the channelized river were analyzed. The four sampling stations analyzed were felt to adequately represent the overall picture of the physical and chemical factors as well as the distribution and diversity of the planktonic and microbenthic organisms of the Missouri River.

The turbidity of the water in the Missouri River was found to be considerably less in the unchannelized river than in the channelized river. The turbidity in the unchannelized river ranged from 5 - 75 Jackson Turbidity Units (JTU'S). Only one time during the study was the turbidity in the unchannelized river greater than 75 JTU's. A reading of 2,000 JTU'S was recorded at station #16 on April 20, 1973. The inflow of ice and snow melting probably caused the water draining into Bow Creek to be more turbid than was normally recorded.

The water samples from the channelized river ranged in turbidity from 22 - 1,800 JTU'S. The average turbidity readings from each month were always greater in the channelized sampling stations than in the unchannelized stations. (Tables 2 - 9).

Investigations by other workers (Morris, Langemeier, Russell, and Witt, 1968) revealed that the average width of the unchannelized river to be 2,363 feet, and the average width of the channelized river to be 789 feet. Therefore, channelization has reduced the surface area of the Missouri River and narrowed the flow of water. These investigators also found that main stream current velocities averaged 3.4mph in the unchannelized river compared to 3.5mph in the channelized river. The channelized river has a narrower

average width and a slightly higher mph current velocity than the unchannelized river. The result of these differences is that the channelized portion of the Missouri River is carrying larger amounts of suspended solids, thus resulting in higher turbidity readings for sampling stations in the channelized river.

Large rivers and smaller streams usually are characterized by having masses of constantly moving water which is thoroughly mixed and usually not stratified as in lakes. The Missouri River is a good example of a constantly moving and thoroughly mixed body of water. The rate of movement of the water greatly affects the availability of organism habitats. It also influences the temperature, dissolved nutrients, oxygen concentration, and the turbidity of the water.

The turbidity readings taken from water samples at Snyder Bend and DeSoto Bend Oxbows range from 5 - 22 JTU'S. These two sampling stations have low turbidity readings which is typical of lentic (standing) water habitats. However, wind turbulence and large numbers of boaters may affect the abundance and displacement of microbenthic and planktonic organisms in the two oxbow lakes.

The pH, or hydrogen-ion concentration was found to vary between 6.8 - 7.9 in the channelized river. The pH in the channelized river was found to be from 6.3 - 8.8. The water analyzed from the sampling stations in the unchannelized river indicate a more restricted pH range than the water from the channelized river. These differences in the pH range may be attributed to the industrial wastes present in the water from the larger cities and towns found adjacent to the Missouri River in the channelized portion of this study. Also, the number of tributary streams that often accumulate agricultural wastes and feedlot runoff are more numerous in the channelized portion of the river than in the unchannelized portion.

The pH of the water in Synder Bend and DeSoto Bend Oxbows ranges from 7.1 - 7.8. This narrow range of pH is probably attributed to the presence of very small amounts of industrial or agricultural pollution. These two sampling stations are no longer connected to the Missouri River and were not influenced by the changing water levels and seasonal characteristics of the Missouri River. Thus, a narrow range of pH would be expected for these two lentic bodies of water.

The species which make up a flora or fauna seem to be greatly influenced by the pH of the water, and waters of different pH lead to very different floras and faunas.

Very few species can live in water below 3.5pH. The pH range of 6.5 - 7.5 demonstrates the greatest diversity of species of diatoms (Kolbe, 1932; Patrick, 1945). The more alkaline waters, those with a pH of above 8, also often show a more or less restricted flora and fauna. In considering the effect of pH, one should think not only of its direct effect upon the organism, but, its even more important indirect influence on the solubility of various substances. Very acid waters support less life than neutral (near pH 7) bodies of water and, thus, the supply of oxygen and carbon dioxide will be limited due to these solubility factors.

Nitrogen, usually in the form of ammonium or nitrates (NO_3), is one of the major mineral requirements of diatoms and most aquatic organisms. The ppm NO_3 in the unchannelized river ranged from 0.22 - 13.2 ppm. In the channelized river the NO_3 content ranged from 0.22 - 26.4 ppm. The higher concentration of NO_3 in the unchannelized river is probably related to the volume of water released from Gavins Point Dam at Yankton, South Dakota. As the water flows south from the dam it becomes thoroughly mixed and any high concentrations of chemical nutrients present at the tailwaters of the dam would become less concentrated as it moved further away from the dam.

The NO_3 concentration at Synder Bend Oxbow ranged from 2.64 - 33.0 ppm, whereas the NO_3 concentration at DeSoto Bend Oxbow only ranged from 0.88 - 8.8 ppm. The high NO_3 reading of 33.0 ppm at Synder Bend in May, 1973 and the reading of 22.0 ppm in August, 1973 are probably related to agricultural fertilizers and chemical weed sprays that have been washed off of surrounding farm land by heavy rains that subsequently drained into the oxbow lake.

Some aquatic organisms seem to grow best when the nitrate concentration is relatively high. Other species actually prefer a lower concentration of nitrate and occur in greater abundance after the nitrate and other nutrients have been depleted by other organsism (Hustedt, 1939). The high nitrate readings in May and August, 1973 at Synder Bend Oxbow may have greatly increased the populations of organisms that were tolerant of higher levels of nitrates. However, almost any mineral or nutrient used by an organism can have a secondary effect which may, in the long run be more damaging. The organisms tolerant of high nitrate concentrations may increase in large numbers for a period of time prior to exhausting the supply of nitrates and related nutrients. The result would be that these organisms that can tolerate high nitrate concentrations would reach a population peak and than quickly die off as the supply of nitrate was exhausted. Other organisms which are not limited by lower levels of nitrate would subsequently increase in number.

Phosphorus is another important nutrient utilized by the aquatic organisms in the Missouri River. Phosphorus, along with nitrogen, are usually found as dissolved salts (PO_4 and NO_3) in an aquatic ecosystem. However, the roles of these salts, which was discussed with nitrates, as environmental factors and the extent to which they limit aquatic productivity varies as the concentration of the salts varies. Most aquatic biological researchers agree that the element that is most consistently suboptimal in aquatic ecosystems, and thus is the most likely candidate for a limiting factor, is phosphorus; followed by nitrogen. The amount of phosphorus or nitrogen dissolved in water in any aquatic ecosystem is closely related to the activity of living organisms. They reach a maximum during the winter, when production and the rate of withdrawal of nutrients from solution by living organisms is at its minimum, then falls sharply as production rises in the spring, and the rate of withdrawal increases. Phosphorus and nitrogen are then released back into the water as organisms die and are broken down by detritus feeding organisms (W. D. Russell-Hunter, 1970).

Depending upon local circumstances, either phosphorus or nitrogen may be the prime limiting factor for community productivity. Some studies, (Russell-Hunter, 1970) have indicated that in a single aquatic ecosystem, nitrogen may be limiting at some times and phosphorus at others. In general, however, phosphorus seems to be limiting more often than nitrogen. The main use for these two nutrients by living organisms is in DNA protein synthesis and genetic machinery. Nitrogen is typically about twenty times more abundant than phosphorus in fresh-water systems.

The phosphorus concentrations were examined as dissolved salts, (PO_4) or phosphates. Tests were run for total phosphate (ortho plus meta phosphate) and for meta phosphate. In nature most of the phosphate is found in the ortho or total phosphate state. Phosphate in the ortho state is the most soluble form and will be the condition reported here. Tables list the phosphate concentrations for both ortho and meta, but we will be concerned primarily with ortho or total phosphate. The ortho phosphate ranged from 0.02 - 1.35 ppm in the unchannelized river to 0.3 - 3.5 ppm in the channelized river. The higher ortho-phosphate readings in the channelized river can be attributed partially to industrial sources and to agricultural sources. Much of the land adjacent to the Missouri River in the channelized portion is agricultural land. Because many agricultural fertilizers contain high concentrations of phosphates, a certain amount of phosphates from farm lands is washed into the Missour River from tributary streams and drainage ditches after heavy rainfall, thus increasing the concentration of phosphorus in the channelized river.

The concentration of ortho phosphate in Synder Bend Oxbow ranges from 0.03 - 0.40 ppm whereas, in DeSoto Bend Oxbow the ortho phosphate concentration ranges from 0.02 - 0.08 ppm. The higher concentration of ortho phosphate in Synder Bend Oxbow is probably the result of heavy rainfall causing agricultural fertilizers containing phosphorus to be washed into the water. This effect is more pronounced at Synder Bend because of the more steeply sloping hills surrounding the oxbow lake.

The water parameters of air temperature, water temperature, and dissolved oxygen (O_2) have a direct relationship with one another and need to be considered as interrelated when discussing them. In general, the dissolved O_2 concentration in the Missouri River and the two oxbow lakes was found to be adequate throughout the study project to support planktonic and microbenthic life, including a variety of fish species. The constant movement of the water in the Missouri River allows for a high dissolved O_2 concentration to exist.

In the unchannelized river the dissolved O_2 concentration during the summer months of July, August, and September, 1972 ranged from 5.4 - 12.5 ppm. During this same time period the water temperature ranged from 20 - 26 degrees Centigrade (^{o}C), and the air temperature ranged from 19 - 29^{o}C. In the fall months, October and November, 1972, the dissolved O_2 concentration ranged from 7.3 - 11.4 ppm; while the water temperature ranged from 6.5 - 12^{o}C, and the air temperature ranged from 4 - 12^{o}C. In the winter months of February and March 1973, the dissolved O_2 concentration ranged from 12.8 - 13.2 ppm; while the water temperature ranged from 0.0 - 1.0^{o}C, and the air temperature ranged from 3 - 8^{o}C. During the spring months of April and May, 1973 the dissolved O_2 concentration ranged from 8.2 - 10.9 ppm; while the water temperature ranged from 9 - 16.5^{o}C, and the air temperature ranged from 16 - 24^{o}C. During the summer months of June and August, 1973 the dissolved O_2 concentration was found to range from 8.6 - 10.2 ppm; while the water temperature ranged from 19 - 28^{o}C, and the air temperature ranged from 19 - 39^{o}C. In analysis of this information it can be seen that the air temperature does affect the temperature of water which in turn has a direct affect on the ability of the water to hold oxygen. In general, the colder the water, the greater ability the water has to hold oxygen. This becomes apparent when reviewing the data in Tables . As the air temperature rises in the summer of 1972, the water temperature also increases which lowers the ability of the water to hold oxygen, thus a lower dissolved O_2 concentration in warmer water. As the air temperature decreases in the fall and winter of 1972 to early in 1973, the water temperature becomes colder, thus increasing the ability of the water to hold oxygen. This results in higher dissolved O_2 concentrations during the fall and winter

months. In the spring and summer months of 1973 we see a gradual increase in water temperatures as the air becomes warmer, which causes a subsequent lowering of the dissolved O_2 concentration of the water. Analysis of the data for air and water temperatures and dissolved oxygen concentrations from Tables shows that the water in the channelized and unchannelized river is affected in the same manner by changes in air and water temperature.

Synder Bend and DeSoto Bend Oxbows were affected by temperature changes in the same manner as the Missouri River. The two oxbows were sampled only from March to August, 1973 and indicated a progressively higher air and water temperature and lower dissolved O_2 concentration. However, another factor must be considered that will affect the dissolved O_2 concentrations of a lentic body of water. Surface wind in lentic bodies of water such as Synder Bend and DeSoto Bend Oxbows, has an important affect on the dissolved O_2 concentration by stirring up the water to such an extent that it can become highly oxygenated. Thus, wind plays an important role in certain aquatic ecosystems as it raises the dissolved O_2 concentration of the water even during the summer months when the dissolved O_2 concentration is typically at a lower concentration.

The effect of temperature on the growth of aquatic organisms seems to be both direct and indirect. The direct effect is seen in the fact that certain organisms are stenotherms and are found only in cold or warm water, other species seem to be eurytherms and are tolerant of a wide temperature range. Also, certain organisms vary as to the season of the year when they are most abudant, thus perhaps reflecting the effect of change of temperature. The indirect effects of temperature on the solubility of salts and bacterial activity is related positively to the metabolism of benthic organisms as their food sources or negatively as inhibiting factors. Temperature also has an influence on the pH because it affects the dissociation coefficients of acids, and the solubility of CO_2. As a rule the pH decreases by 0 - 1 pH unit with a temperature increase of 20°C. In general, the distribution of fresh-water organisms seems to be most closely correlated with the chemistry of the water, its rate of flow, and temperature.

TABLE 2

CHEMICAL AND PHYSICAL CHARACTERISTICS OF THE MISSOURI RIVER DURING THE SUMMER MONTHS JULY, AUGUST AND SEPTEMBER, 1972

	UNCHANNELIZED		CHANNELIZED	
PARAMETER	RANGE	AVERAGE	RANGE	AVERAGE
Air temperature	19-29	24	9.0-32	22
Water temperature	20-26	23	11-29	23
Turbidity	5-26	16	23-1,800	298
pH	6.8-7.7	(1)	6.3-8.5	7.3
NO_3 (Nitrates)	0.22-13.2	5.9	0.22-13.2	4.50
PO_4 (ortho-phosphate)	0.02-0.14	0.06	0.03-3.50	0.64
PO_4 (meta-phosphate)	0.06-0.62	0.15	0.01-1.45	0.31
Dissolved O_2	5.4-12.5	9.8	5.7-11.5	8.9

Temperature as degrees Centigrade, pH in pH units, turbidity in Jackson Turbidity Units, all other values as ppm (parts per million).

1. The pH values can not be averaged because the pH scale is a logarithmic scale

TABLE 3

CHEMICAL AND PHYSICAL CHARACTERISTICS OF THE MISSOURI RIVER DURING THE FALL MONTHS OCTOBER AND NOVEMBER, 1972

	UNCHANNELIZED		CHANNELIZED	
PARAMETER	RANGE	AVERAGE	RANGE	AVERAGE
Air temperature	4-12	7.5	13-14	13.5
Water Temperature	6.5-12	8.5	9-11	10.3
Turbidity	5-20	12	22-95	63
pH	7.7-7.9	(4)	7.4-8.0	7.8
NO_3 (Nitrates)	4.4-6.6	5.5	2.2-8.8	5.0
PO_4 (ortho-phosphates)	0.04-0.15	0.09	0.07-0.48	0.3
PO_4 (meta-phosphates)	0.11-0.55	0.33	0.11-0.49	0.21
Dissolved O_2	7.3-11.4	9.8	10.1-11.7	11.2

1. Temperature as degrees Centigrade, pH in pH units, turbidity in Jackson Turbidity Units, all other values as ppm. (parts per million).
2. There was only two stations sampled in the unchannelized river during October and November.
3. There were no stations in the channelized river during November.
4. The pH values can not be averaged because the pH scale is a logarithmic scale.

TABLE 4

CHEMICAL AND PHYSICAL CHARACTERISTICS OF THE MISSOURI RIVER DURING THE WINTER MONTHS FEBRUARY AND MARCH, 1973

	UNCHANNELIZED		CHANNELIZED	
PARAMETER	RANGE	AVERAGE	RANGE	AVERAGE
Air temperature	3-8	5.5	6-10	7.5
Water temperature	0.0-1.0	0.5	7.0-7.5	7.2
Turbidity	5-12	8.5	105-375	260
pH	N.D.	N.D. (5)	6.8-8.8	7.7
NO_3 (Nitrates	3.96-6.6	5.28	6.6-22.0	13.2
PO_4 (ortho-phosphate)	0.02-0.04	0.03	0.45-1.22	0.93
PO_4 (meta-phosphate)	0.11-0.11	0.11	0.43-1.60	1.23
Dissolved O_2	12.8-13.2	13.0	8.1-10.2	9.2

1. Temperature as degrees Centigrade, pH in pH units, turbidity in Jackson Turbidity Units, all other values as ppm. (parts per million).
2. There were no stations sampled in the channelized river during February, 1973.
3. There were no stations sampled in the unchannelized river during March, 1973. Only two unchannelized stations were sampled during February, 1973.
4. N.D. = Not Determined.
5. The pH values can not be averaged because the pH scale is a logarithmic scale.

TABLE 5

CHEMICAL AND PHYSICAL CHARACTERISTICS OBTAINED FROM SYNDER BEND AND DeSOTO BEND OXBOWS

MARCH, 1973

PARAMETER	STATION #17 SYNDER BEND OXBOW	STATION #18 DeSOTO BEND OXBOW
Air temperature	12	8
Water temperature	10	9
Turbidity	10	15
pH	7.1	7.1
NO_3 (Nitrates)	4.4	4.4
PO_4 (orthophosphate)	0.06	0.08
PO_4 (metaphosphate)	0.39	0.60
Dissolved O_2	12.1	11.7

1. Temperature as degrees Centigrade, pH in pH units, turbidity in Jackson Turbidity Units, all other values as ppm. (parts per million).

2. These results are not averaged because both of these Oxbows were sampled only once each month beginning in March, 1973.

TABLE 6

CHEMICAL AND PHYSICAL CHARACTERISTICS OF THE MISSOURI RIVER DURING THE SPRING MONTHS APRIL AND MAY, 1973

	UNCHANNELIZED		CHANNELIZED	
PARAMETER	RANGE	AVERAGE	RANGE	AVERAGE
Air temperature	16-24	19	8-20	13.5
Water temperature	9-16.5	12	8-16	13
Turbidity	8-2,000[2]	509	38-320	136
pH	7.3-7.7	(3)	6.9-7.8	7.5
NO_3 (nitrates)	0.44-4.40	2.31	0.44-26.4	6.6
PO_4 (ortho-phosphate)	0.03-3.65	0.96	0.25-0.95	0.53
PO_4 (meta-phosphate)	0.11-1.35	0.44	0.07-0.65	0.35
Dissolved O_2	8.2-10.9	9.9	7.3-10.2	8.7

1. Temperature as degrees Centigrade, pH in pH units, turbidity in Jackson Turbidity Units, all other values as ppm. (parts per million).

2. A very high reading of 2,000 JUT'S was recorded at the mouth of Bow Creek, Nebraska. The turbid water was cuased by spring runoff.

3. The pH values cannot be averaged because the pH scale is a logarithmic scale.

TABLE 7

CHEMICAL AND PHYSICAL CHARACTERISTICS OBTAINED FROM SYNDER BEND AND DeSOTO BEND OXBOWS

APRIL AND MAY, 1973

	APRIL		MAY	
PARAMETER	STATION #17 SYNDER BEND OXBOW	STATION #18 DeSOTO BEND OXBOW	STATION #17 SYNDER BEND OXBOW	STATION #18 DeSOTO BEND OXBOW
Air temperature	14	14	20	12
Water temperature	14	8	17	15
Turbidity	22	10	10	5
pH	7.6	7.5	7.3	7.7
NO_3 (Nitrates)	2.64	8.8	33.0(3)	0.88
PO_4 (ortho-phosphate)	0.08	0.03	0.07	0.02
PO_4 (meta-phosphate)	0.28	0.13	0.21	0.01
Dissolved O_2	9.2	11.7	10.4	8.3

1. Temperature as degress Centigrade, pH in pH units, turbitiy in Jackson Turbidity Units, all other values as ppm (parts per million).

2. These results are not averaged because both of these Oxbows were sampled only once each month.

3. The high nitrate reading in May at Station #17 may be attributed to runoff from heavy rains from surrounding agricultural lands. There may have been something in the water that affected the immediate area where the sample was obtained.

TABLE 8

CHEMICAL AND PHYSICAL CHARACTERISTICS OF THE MISSOURI RIVER DURING THE SUMMER MONTHS JUNE AND AUGUST, 1973

	UNCHANNELIZED		CHANNELIZED	
PARAMETER	RANGE	AVERAGE	RANGE	AVERAGE
Air temperature	19-39	28	16-30	24.5
Water temperature	19-28	23	19-27	23
Turbidity	5-75	29	35-300	98
pH	7.4-7.9	(1)	7.0-8.6	7.6
NO_3 (Nitrates)	0.44-6.6	2.0	0.44-26.4	3.83
PO_4 (ortho-phosphate)	0.04-0.40	0.16	0.06-0.71	0.37
PO_4 (meta-phosphate)	0.22-0.81	0.37	0.01-1.04	0.39
Dissolved O_2	8.6-10.2	9.9	6.6-13.1	8.1

Temperature as degress Centigrade, pH in pH units, turbidity in Jackson Turbidity Units, all other values ppm (parts per million).

1. The pH values cannot be averaged because the pH scale is a logarithmic scale.

TABLE 9

CHEMICAL AND PHYSICAL CHARACTERISTICS OBTAINED FROM SYNDER BEND AND DeSOTO BEND OXBOWS

JUNE AND AUGUST, 1973

	JUNE		AUGUST	
PARAMETER	STATION #17 SYNDER BEND OXBOW	STATION #18 DeSOTO BEND OXBOW	STATION #17 SYNDER BEND OXBOW	STATION #18 DeSOTO BEND OXBOW
Air temperature	23	21	23	26
Water temperature	22	22	24	26
Turbidity	5	5	35	28
pH	7.4	7.7	7.3	7.8
NO_3 (Nitrates)	6.6	2.2	22.0	1.76
PO_4 (ortho-phosphate)	0.40	0.05	0.03	0.03
PO_4 (meta-phosphate)	0.43	0.06	0.21	0.08
Dissolved O_2	12.2	9.1	8.0	10.6

1. Temperature as degrees Centigrade, pH in pH units, turbidity in Jackson Turbidity Units, all other values as ppm (parts per million)

2. These results are not averaged because both of these Oxbows were sampled only once each month.

DISCUSSION ON THE ORGANISMS IDENTIFIED IN THE MISSOURI RIVER:

DISTRIBUTION:

Diatoms occur in all types of fresh and salt water habitats, and in some moist and dry habitats where the light, temperature, and chemical conditions are suitable for their growth.

The "plankton" diatoms found in freshwater are commonly benthic neritic species which spend the vegetative part of their life cycle afloat. Many diatoms found in the plankton of freshwater also occur in littoral habitats (the shallow-water region with light penetration to the bottom; typically occupied by rooted plants in quiet back-water chutes along the shoreline of the river). Planktonic diatoms vary a great deal in size and might roughly be divided into small forms or nannoplankton, and large forms or net plankton. The nannoplankton consist, among other, of species of the genera Stephanodiscus and Cyclotella. The net plankton owe their size to colony formation or to the size of the individual. To this group belong the genera Synedra, Asterionella, Melosira, Fragilaria, and Pinnularia. Although plankton diatoms are usually in some way particularly adapted for this mode of life, there are some genera such as Nitzschia, Surirella, and Cymatopleura, which are found in plankton or littoral habitats.

HABITAT PREFERENCE:

Bottom Forms: The bottom diatoms are those which live on the substrate. Most of them have motility and may live in shallow or deep water, depending on the light penetration and the amount of O_2, H_2S, CH_4, and CO_2 present. Temperature also limits their distribution so that in shallow water in very cold weather the benthic flora is greatly reduced. This flora is often well developed in streams and rivers in places where the current is not too swift. To this flora belong many genera such as Navicula, Surirella, Nitzschia, and Pleurosigma.

Epiphytic Forms: The epiphytic forms are those which attach themselves by a secretion of jelly to the substratum. This jelly may form a cushion; a tube in which the diatoms live; or stalk-like structures, as are found in Cymbella and Gomphonema. In other cases, by the secretion of jelly the whole organism may be attached to the substratum, as in the genera Achnanthes and Cocconeis. Diatoms may live epiphytically on a great many different types of substrate, being abundant on rocks and rooted vegetation.

In rivers and streams the amount of current greatly influences the kinds of diatoms which may be present. Allan (1920) points out that current flow above a very modest speed is distinctly unfavorable to plankton development. In fast flowing streams only those forms which can attach themselves by a gelatinous mass or stalks can survive. These species are often called rheophils. The typical genera of such habitats are Achnanthes, Cocconeis, Cymbella, and Gomphonema. The amount of current has been found also to affect the habitat of diatoms. Plankton development is usually scarce except in places where the current is reduced. Often along the edges and on the stream bed, or in little pools or chutes where the current is not very great, a benthic flora will develop.

Many of the species found in the plankton are often the same as those found in the littoral zone and are derived from this source. In the Missouri River there is constant rolling and mixing of the flowing water. This tends to thoroughly disperse the various species from their normal habitat throughout the total area of the river. The time at which species reach their maximum numbers seems to be more closely correlated with the temperature of the water, the dissolved nutrients, and gases than with the calendar month of the year. At any given time, due to varying ecological factors, blooms may develop in some stretches of a river and not in others (Claus and Reimer, 1961). Most algal blooms occur when growth conditions permit the formation of a "bloom". A bloom is an unusually large number of cells (usually one or a few species) per unit of surface water, which often can be discerned visually by the green, blue-green, brown, or even brilliant red discoloration of the water. Lackey (1949) arbitrarily defined a bloom as 500 individuals per ml of raw water. The source of the species which make up the plankton of a river seem to vary, but in most instances it is the benthic or epiphytic communities of the river.

Analysis of the data collected on the numbers of organisms per unit area or per unit of volume will be discussed on the information gathered from two sampling stations in the unchannelized river, two stations in the channelized river, and Synder Bend and DeSoto Bend Oxbow lakes. The information gathered from these six sampling stations will give a representative view of the diversity of species that are found in the Missouri River. Tables 11-69 list the most common organisms found and identified at these various stations from July, 1972 to August, 1973. In general, most of the organisms were identified to genera because of the time involved with positive species identification.

The summer months of July, August, and September, 1972 were characterized by having the diatom genera Navicula, Fragilaria, and Cymbella as the most abundant benthic forms in the unchannelized river. The channelized river was dominated by the diatom genera Fragilaria and Cyclotella. The plankton during this time in both the unchannelized and channelized river was dominated by the diatom genera Cyclotella and Melosira, with the addition of Stephanodiscus as an important genus in total numbers in the channelized river. The genera Cyclotella and Melosira were found in larger numbers in the channelized river than in the unchannelized river.

The protozoans of the benthos in the summer of 1972 were characterized by the dominance of flagellated species of the genus Chilomonas in both the channelized and unchannelized river. The plankton demonstrated numerous members of both the flagellated and ciliated protozoan forms in the unchannelized river. Species of the genus Strombilidium were the most common ciliated form whereas, species of Chilomonas dominated the flagellated forms. These organisms respectively, were also the most common ciliates and flagelletes in the channelized river. The flagellate, Chilomonas sp. was the most dominant type in both the plankton and benthos habitat in the channelized and unchannelized river.

During the summer of 1972 the most common metazoan found in the benthos of the chnnelized and unchannelized river was various species of Gastrotricha. Planktonic metazoan most commonly found were members belonging to the Rotifera grouping in both the channelized and unchannelized river. Some species of Gastrotricha were never found in numbers greater than 1.5×10^7 in the benthos while the rotifers were never more abundant than 5 organisms per ml in the plankton.

The benthos habitat during the fall months of October and November, 1972 was dominated by the diatom genera Navicula and Fragilaria in the unchannelized river. The benthos of the channelized river was dominated by the genera Melosira, Cyclotella, and Synedra. The genera Cyclotella, Synedra, and Navicula dominated the plankton in the unchannelized river in the fall months; whereas, the genera Cyclotella and Fragilaria dominated the channelized river.

The dominant protozoan forms found during the fall months were the same organisms that were present during the summer months of 1972. Metazoans appeared to be absent from the fall samples either due to their low numbers or to the sampling techniques.

The winter months of February and March, 1973 were characterized with the genera Asterionella and Amphora as being the most abundant diatoms in the benthos of the unchannelized river. The benthos of the channelized river was dominated by the diatom genera Melosira and Fragilaria. The dominance of Asterionella and Amphora in the unchannelized river and not in the channelized river can be explained partially on the basis of the effect of the water which is released from Gavins Point Dam. The amount of water released from the dam and the season of the year play an important role in the diversity and abundance of the organisms which are found below the dam. During the winter months there is very little inflow of water into the Missouri River from tributary streams. Thus, the organisms present in the unchannelized river during the winter months are to a large extent dependent upon the types of organisms present in Lewis and Clark Lake above Gavins Point Dam. The diatoms Asterionella and Amphora are typical of those found in eutrophic water conditions (Patrick, 1966). Eutrophic lakes are characterized by being nutrient rich, having an oxygen depletion in the lower depths, high in turbidity, large populations of organisms, but low diversity of organisms. This condition describes the ecosystem present in Lewis and Clark Lake. Since Asterionella and Amphora grow better under these conditions than other forms they would tend to dominant the diatom populations in the water above the dam. As water is released from the dam, the organisms entering the unchannelized river will reflect the dominant types found in the water above the dam.

The plankton during February and March in the unchannelized river was dominated by the genus Asterionella. Its dominance as a planktonic species is again the result of the direct influence from the water that is released from Gavins Point Dam. The channelized river was dominated by the genera Cyclotella, Fragilaria, and Synedra.

The most abundant protozoan species in the benthos of the unchannelized river were found to be the ciliate Paramecium aurelia and the flagelleted species of the genus Chilomonas. The benthos of the channelized river had flagellated species of Chilomonas and the ciliate Vorticella as the most abundant protozoan forms. Vorticella sp. are stalked forms of protozoa that typically attach themselves to rooted vegetation or other substrata. As the water level in the Missouri River drops during the winter months, and as ice forms along the banks where vegetation is most abundant, many of the species of Vorticella become dettached from their normal habitat and are set adrift; thus, becoming more abundant during this period of time. In general, the channelized and unchannelized river were dominated by flagellated species of the genus Chilomonas as the most common form in the benthos.

The plankton during February and March, 1973 yielded species of the genus Chilomonas as the most abudnant flagellate in the channelized and unchannelized river. The species of the ciliate Vorticella and the ciliate Paramecium aurelia were found to be the most dominant. On the basis of total numbers, the plankton was dominated by the flagellated species Chilomonas as being the most abundant protozoan.

There were no metazoan species present during the winter months of February and March, 1973 in either the benthos or plankton of the channelized and unchannelized river. Apparently these species seem to be less adapted to live during periods of colder water temperatures or depend upon the egg stage of their life cycle to overwinter.

The most abundant diatom genera in the benthos at Synder Bend Oxbow during March, 1973 were Synedra and Fragilaria, whereas the plankton was dominated by Synedra and Nitzschia. DeSoto Bend Oxbow had the genera Melosira and Fragilaria as the most abundant diatoms in the benthos and Synedra and Navicula as the most abundant diatoms in the plankton. Synder Bend Oxbow was dominated by flagellated species of the genus Chilomonas as the most abundant protozoan in the benthos and plankton. At DeSoto Bend Oxbow the most protozoan in both the benthos and the plankton was the flagellated species of Chilomonas. Species of the genus Vorticella were the most abundant ciliated protozoan found in the plankton at DeSoto Bend Oxbow, whereas, no ciliate species were identified in the benthos. No metazoan species were recorded in the benthos or in the plankton at Synder Bend Oxbow, while Nematodes were found in the benthos at DeSoto Bend Oxbow, but were absent from the plankton.

The benthos in the spring months of April and May, 1973 in the unchannelized river was dominated by the diatoms of the two genera Asterionella and Synedra. The channelized river was dominated by the genera Cyclotella, Fragilaria, and Synedra. The most abundant diatom genera in the plankton of the unchannelized river were Asterionella, Cyclotella, and Fragilaria; whereas, the plankton in the channelized river was dominated only by the diatom genera Cyclotella and Asterionella.

The most abundant protozoans found during April and May, 1973 in the benthos of the unchannelized and channelized river were the ciliated species of Strombilidium and the flagellated species of Chilomonas. These species respectively were also the most abundant types found in the plankton in the channelized and unchannelized river. The only excertion was that species of Dinobryon occurred along with species of Chilomonas as the dominate flagellates in the plankton.

There was no metazoan species found in the benthos of the channelized or the unchannelized river during the months of April and May, 1973. Rotifers were numerous in the plankton in the unchannelized river but were absent in the channelized river. The reason for the absence of rotifers in the channelized river is, that only two sampling stations were analyzed in this report and thus may have excluded their presence. Data collected from other sampling stations in the channelized river indicates the presence of this organism in the plankton samples.

The dominant diatom genera in the benthos and plankton at Synder Bend Oxbow during April and May, 1973 were Synedra and Cyclotella. DeSoto Bend Oxbow had the genera Synedra and Melosira as the most abundant diatom genera in the benthos and plankton. The most abundant protozoan found in the benthos at Synder Bend and DeSoto Bend Oxbows were the same species that were found in March. No ciliate protozoans were found in the benthos at Synder Bend or DeSoto Bend Oxbows during the spring months. The dominant ciliates in the plankton at Synder Bend Oxbow were Paramecium aurelia and species of the genus Strombilidium; whereas, in DeSoto Bend Oxbow the dominant ciliate species were from the genera Strombilidium and Nassula. The two most abundant flagellated protozoans in Synder Bend and DeSoto Bend Oxbow plankton samples were species of the genera Chilomonas and Cryptomonas.

The summer months of June and August, 1973 were found to have the genera Synedra, Fragilaria, and Navicula as the most abundant diatoms in the benthos of the unchannelized river and the genera Cyclotella and Synedra as the most common diatoms found in the benthos of the channelized river. The genera Synedra, Navicula, and Fragilaria were the most abundant diatoms in the plankton of the unchannelized river; whereas, the genera Cyclotella, Syndera, and Melosira were the most abundant diatoms in the plankton of the channelized river.

The protozoans were not found in any great numbers in the benthos during June and August, 1973, whereas, they were more abundant in the plankton. Species of the genus Chilomonas were the most abundant flagellated form in the benthos of the unchannelized river and in the plankton of the channelized and unchannelized river. Species of Chilomonas were not recorded in the benthos of the channelized river. Ciliate species were not recorded in the benthos of the channelized and unchannelized river; whereas, species of the ciliate genera Strombilidium and Codonella were abundant in the plankton of both the channelized and unchannelized river.

Synder Bend Oxbow was dominated in June and August, 1973 by the diatom genera Fragilaria, Navicula, and Synedra as the most abudnant genera in the benthos. DeSoto Bend Oxbow had the genera Fragilaria, Asterionella, and Melosira as the most abundant diatoms in the benthos. The plankton at Synder Bend was dominated by Cyclotella and Synedra, as the most common diatom genera. At DeSoto Bend Oxbow the most common diatom genera of the plankton were Asterionella and Synedra. The presence of Melosira as a dominant diatom in DeSoto Bend Oxbow during June and August, 1973 can probably be explained by the low nitrogen and phosphorus concentrations recorded during these months. Diatom species such as Melosira actually prefer a low nitrate - phosphate ratio, for it often occurs after the nutrients have been exhausted by other diatoms (Hustedt, 1939).

The most abundant flagellated protozoan in the benthos and plankton at Synder Bend and DeSoto Bend Oxbows during June and August, 1973 were species of the genus Chilomonas. No ciliates were recorded in the benthos at Synder Bend Oxbow, but ciliate species of the genera Didinium and Strombidium were abundant in the plankton at Synder Bend Oxbow. Species of the genus Spirostomum were the most abundant ciliate in the benthos at DeSoto Bend Oxbow, while species of the genus Vorticella were the most abundant ciliate in the plankton.

The Missouri River Environmental study for the planktonic and microbenthic organisms had originally planned to sample the Aufwuchs of the Missouri River. The term Aufwuchs, as it was proposed by Ruttner, (1953) means organisms (both plant and animal) attached or clinging to stems and leaves of rooted plants or other surfaces that are projecting above the bottom. These organisms are many times torn loose from their habitat and set adrift by the swift current present in the Missouri River. A Hester-Dendy sampler, as described in methods and materials, was used for the collection of these organisms. The Hester-Dendy sampler provides a surface for re-attachement of these migratory organisms. Through periodical examination of the samplers, a measurement of the rate of recolonization can be obtained. Initiation of sampling for the aufwuchs began in July, 1972 but was discontinued after several months because the information gained did not justify the time involved and the expenses in travel due to the distances involved in the sampling of several stations at a regular weekly basis throughout the range of the survey. Because of these factors and the problem of disassemblance of the Hester-Dendy samplers in cold weather as the fall of 1972 approached, the sampling for the macrobenthic organisms was discontinued. Also, the problem of the constantly fluctuating water levels in the Missouri River made sampling for these organisms on any regular basis most difficult. It was decided that by a thorough review of the more recent studies of these organisms in the Missouri River compiled by (Morris, 1965) and (Morris, Langemeier, Russell, and Witt; 1968), information could be obtained as to the abundance and diversity of these organisms.

The physical effect of channelization in the Missouri River may be best exemplified by its effect on the standing crop of benthos. Because of the difficulty in identification of fragile forms found in the benthos and because few benthic organisms were found to be consumed directly by species of fish, it was concluded that the benthos has little value as an index for evaluating the differences in growth rates of fish between the unchannelized and channelized areas of the Missouri River. Drift, however, was found to be a better index to the differences in growth rate than the benthos as the quality and quantity of drift was more closely related to the food habitats and growth of flathead catfish in both the unchannelized and channelized areas of the river (Morris, 1965). It was proposed by Morris, (1965) that drift (as defined by Berner, 1951) is important as an indicator of the relative availability of insects as food for fishes since the current is non-selective in its action.

His hypothesis was supported by the food habits of young-of-the-year channel catfish whose stomachs were examined for diversity of food content. That there was a direct relationship between specific drift organisms and the same organisms in the stomachs of young channel catfish substantiated the proposed hypothesis of Morris,(1965) that drift is a valid indicator of the relative abundance of insects as food for young fishes.

Morris (1965) calculated the standing crop of macro-benthic forms in the unchannelized river from Yankton, South Dakota to Ponca, Nebraska to be 1.03 pounds per acre; and 0.44 pounds per acre for the channelized river from Ponca, Nebraska to the end of the survey project at Rulo, Nebraska. The low figures on the macrobenthos standing crop in the Missouri River is not surprising since it possesses many of the characteristics that others have associated with low production of benthos (Morris, 1968). As reviewed by Berner (1951) these were: Shifting substrate, fluctuating water level, swift current, and the absence of large amounts of aquatic vegetation. Other studies (Morris, 1965) indicate that in the channelized river only one-third as much area per mile of stream was under water as in the unchannelized river. In other words, channelization reduced the available benthic habitat by approximately 67 percent. This results in an extremely high net loss of aquatic habitat that is related to potential loss in productivity of esthetic and economic values.

Oligochaeta were the most abundant organisms in the benthos of the channelized river where they commonly occur in the deep silt substrates of chutes and mud banks. They were not nearly so abundant in the same habitats in the unchannelized river where the water was less turbid and the bottom more sandy. The increase in abundance of the Oligochaeta in the channelized river was probably the result of an increase in turbidity resulting in increased silt deposition on the bottom (Morris, 1968).

Ephemeroptera and Trichoptera were the most abundant benthic forms in the unchannelized river. They were most common in chutes and mud bank habitats (usually containing varying amounts of sand) of the relatively clear water of the unchannelized river. Pennak (1953) commented that Ephemeroptera occur in fresh waters wherever there is an abundance of oxygen. Thus, their abundance in the unchannelized river may be related to the greater amounts of dissolved oxygen present in the water immediately downstream from Gavins Point Dam.

Tendipedids did not represent a large percent of the benthos organisms. Apparently the midges are better adapted for survival in sandy bottoms because it is in these areas that they were most abundant (O'Connell and Campbell, 1953).

The average standing crop of the main stream macrobenthos was greater in the unchannelized section of the river than in the channelized river. Average standing crops in the chutes and mud banks were greater in the channelized portion of the river than in the unchannelized portion. Large standing crops of benthos in the chutes and mud banks of the channelized river were probably related to the increase in silt turbidity. Some of the silt settles out to form stable silty bottoms that are better suited for habitation by these organisms than in the shifting substratum of the sandy chutes and mud banks in the unchannelized river. Oligochaetes exhibit the greatest response to the habitable mud bottoms and they became more abundant in the channelized river.

Two major groups of organisms occurred in the drift as reported by Morris (1965 and 1968). Crustacea were the most abundant group in the unchannelized river and the Insecta were the most abundant group in the channelized river. In the unchannelized river 87 percent by weight, of all the Crustaceans were found to be a limnetic Cladoceran. In the channelized river 85 percent of the Crustacea were members of the family Daphnidae.

The standing crop of drift was much larger in the unchannelized section of the river than it was in the channelized river. At the unchannelized portion of the river the average standing crop was only 8.0 grams per acre-foot. Moreover, it was estimated by Morris (1968) that 1, 158 pounds of organisms flowed past a fixed point in the unchannelized river in 24 hours while in the channelized river only 652 pounds of organisms passed a fixed point during the same time. A general similarity between the species composition of the drift and benthos has been reported by Berner (1951), and Muller (1954). The results from these investigators did not deviate dramatically from those of Morris (1965 and 1968). Variations as to the seasons sampled and methods of collection probably explains the lack of similarity in the results of these investigators.

Because a large percentage of the drift was composed of Aufwuchs, it appears that drift may be a better index to the relative availability of organisms as food for fishes than it is the content of the benthos. If Aufwuchs were more readily subjected to removal from the substrate by the current, these organisms could be more easily preyed upon by fishes than the benthic displaced by the current.

TABLE 10

PLANKTONIC AND MICROBENTHIC FLORA AND FAUNA IDENTIFIED IN THE MISSOURI RIVER AND ADJACENT OXBOW LAKES

The organisms listed below are listed under their scientific name only, because no common name for them exists.

Taxonomic Group

Kingdom - Plant
Phylum - Chrysophyta
Division - Bacillariophyta (Diatoms)

Navicula
Cymbella
Gomphonema
Fragilaria
Cyclotella
Amphora
Surirella
Anomoeoneis
Nitzschia
Cymatopleura
Cocconeis
Caloneis
Mastogloia
Neidium
Diploneis
Epithemia
Melosira
Synedra
Asterionella
Stephanodiscus
Eunotia
Gyrosigma
Frustulia
Achnanthes
Pinnularia
Pleurosigma
Opephora
Rhopalodia
Diatoma
Rhoicosphenia
Meridion
Stauroneis
Hantzschia
Amphipleura
Denticula
Amphiprora

Kingdom - Protista
Phylum - Protozoa
Subphylum - Mastigophora (Flagellates)

Chilomonas sp.
Euglena sp.
Dinobryon sp.
Trachelomonas sp.
Gymnodinium sp.
Mallomonas sp.
Amphidinium sp.
Cryptomonas sp.
Rhodomonas sp.
Peridinium sp.
Ceratium sp.
Glendodinium sp.
Lepocinclis sp.

Subphylum - Ciliophora (Ciliates)

Strombilidium sp.
Vorticella sp.
Codonella sp.
Vaginicola sp.
Paramecium aurelia
Amphileptus sp.
Epistylis sp.
Colpoda steini

Didinium sp.
Oxytricha sp.
Frontonia sp.
Strombidium sp.
Nassula sp.
Colpoda sp.
Enchelys sp.
Pseudoprorodon sp.
Spirostomum sp.
Miscellaneous Ciliate species

Subphylum - Sarcodina

Amoeba sp.
Actinosphaerium sp.

Kingdom - Animal
Phylum - Nematoda

Nematodes

Phylum - Rotifera

Rotifers

Phylum - Arthropoda
Subphylum - Mandibulata
Class - Crustacea
Subclass - Branchiopoda
Family - Daphnidae
Genus - Daphnia

Subclass - Copepoda

Copepods

Further effort is being extended to identify more positively the metazoans which include the nematodes, gastrotrichs, rotifers, and crustaceans.

TABLE 11

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING JULY, 1972

UNCHANNELIZED RIVER

GENERA	STATION #1 (7-17-72) % ABUNDANCE	CELLS PER (m^2)	GENERA	STATION #7 (7-31-72) % ABUNDANCE	CELLS PER (m^2)
Navicula	26	6.8×10^9	Fragilaria	25	2.4×10^8
Cymbella	15	4.0×10^9	Navicula	18	1.7×10^8
Fragilaria	12	3.2×10^9	Synedra	15	1.4×10^8
Amphora	10	2.7×10^9	Cyclotella	13	1.2×10^8
Surirella	9	2.4×10^9	Cymbella	8	0.8×10^8
Others	28	7.0×10^9	Others	21	2.0×10^8

CHANNELIZED RIVER

GENERA	STATION #4 (7-21-72) % ABUNDANCE	CELLS PER (m^2)	GENERA	STATION #6 (7-28-72) % ABUNDANCE	CELLS PER (m^2)
Navicula	26	9.2×10^7	Fragilaria	74	31.3×10^9
Gomphonema	22	7.6×10^7	Navicula	9	3.8×10^9
Fragilaria	22	7.6×10^7	Cyclotella	4	1.5×10^9
Synedra	13	4.6×10^7	Pleurosigma	4	1.5×10^9
Nitzschia	9	3.1×10^7	*		
Others	8	3.0×10^7	Others	9	4.2×10^9

*Only cited top 4.

TABLE 12

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING JULY, 1972

UNCHANNELIZED RIVER

STATION #1 (7-17-72)			STATION #7 (7-31-72)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Melosira	23	50	Cyclotella	36	100
Cylcotella	23	50	Melosira	17	48
Synedra	16	36	Navicula	12	31
Navicula	12	29	Syndera	9	26
Nitzschia	10	22	Nitzschia	6	17
Others	16	35	Others	20	56

CHANNELIZED RIVER

STATION #4 (7-21-72)			STATION #6 (7-28-72)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Cyclotella	21	170	Melosira	43	242
Navicula	20	166	Cyclotella	30	173
Synedra	17	135	Synedra	9	52
Melosira	12	100	Navicula	6	35
Nitzschia	11	87	*		
Others	19	155	Others	12	68

*4 abundant species.

TABLE 13

THE TWO MOST ABUNDANT SPECIES OF CILIATES AND FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

JULY, 1972

UNCHANNELIZED RIVER

CILIATE SPECIES	STATION #1 (7-17-72) % OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	STATION #7 (7-31-72) % OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	3.1×10^8	Chilomonas	100	1.5×10^7
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

CILIATE SPECIES	STATION #4 (7-21-72) % OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	STATION #6 (7-28-72) % OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 14
THE TWO MOST ABUNDANT SPECIES OF CILIATES AND FLAGELLATES
IN THE PLANKTON SAMPLES COLLECTED DURING

JULY, 1972

UNCHANNELIZED RIVER

STATION #1 (7-17-72)			STATION #7 (7-31-72)		
CILIATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE	% ABUNDANCE	ORGANISMS PER 1.0 ml
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml
Chilomonas	100	50	Chilomonas	100	166
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

Station # 4 (7-21-72)			SITE # 6 (7-28-72)		
CILIATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE	% ABUNDANCE	ORGANISMS PER 1 ml
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 15

THE TWO MOST ABUNDANT SPECIES OF CILIATES AND FLAGELLATES
IN THE PLANKTON SAMPLES COLLECTED DURING

July, 1972

CHANNELIZED RIVER

STATION # 4
(7-21-72)

FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml
	0	0	Chilomonas	78	121
	0	0	Euglena	22	35
Others	0	0	Others	0	0

TABLE 16

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING AUGUST, 1972

UNCHANNELIZED RIVER

STATION #1 (8-10-72) (Nebraska side)			STATION #8 (8-1-72)		
GENERA	% OF ABUNDANCE	CELLS PER (m^2)	GENERA	% OF ABUNDANCE	CELLS PER (m^2)
Gomphonema	31	3.8×10^8	Navicula	17	4.2×10^8
Synedra	31	3.8×10^8	Cyclotella	14	3.4×10^8
Navicula	18.	2.3×10^8	Fragilaria	13	3.1×10^8
*			Neidium	10	2.3×10^8
*			Nitzschia	8	1.9×10^8
Others	20	2.4×10^8	Others	38	9.3×10^8

*Only top 3 cited as dominant.

CHANNELIZED RIVER

STATION #4 (8-18-72)			STATION #6 (8-23-72)		
GENERA	% OF ABUNDANCE	CELLS PER (m^2)	GENERA	% OF ABUNDANCE	CELLS PER (m^2)
Cyclotella	58	45.8×10^8	Cyclotella	34	38.1×10^8
Melosira	17	13.3×10^8	Fragilaria	33	36.6×10^8
Stephanodiscus	16	13.0×10^8	Melosira	11	13.0×10^8
Synedra	3	2.7×10^8	Stephanodiscus	9	9.9×10^8
*			*		
Others	6	5.0×10^8	Others	13	14.6×10^8

*Only top 4 cited as dominant.

TABLE 17

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING AUGUST, 1972

UNCHANNELIZED RIVER

STATION #1 (8-10-72) (Nebraska side)			STATION #8 (8-1-72)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Cyclotella	43	235	Melosira	62	308
Stephanodiscus	17	95	Cyclotella	17	85
Synedra	12	62	Stephanodiscus	8	42
Navicula	7	40	Synedra	4	21
Cymbella	6	35	*		
Others	15	81	Others	8	44

CHANNELIZED RIVER

STATION #4 (8-18-72)			STATION #6 (8-23-72)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml	GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Cyclotella	39	13,176	Cyclotella	42	941
Melosira	33	11,238	Melosira	28	640
Stephanodiscus	19	6,581	Stephanodiscus	17	388
Synedra	8	2,630	Synedra	6	138
*			Fragilaria	4	97
Others	2	588	Others	3	70

*Only top 4 cited as dominant.

TABLE 18

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

AUGUST, 1972

UNCHANNELIZED RIVER

STATION #1 (8-10-72) (Nebraska side)			STATION #8 (8-1-72)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	1.5×10^8		0	0
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

STATION #4 (8-18-72)			STATION #6 (8-23-72)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	3.1×10^8		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 19

THE TWO MOST ABUNDANT CILIATE AND FLAGELLATE SPECIES IN THE PLANKTON SAMPLES COLLECTED DURING

AUGUST, 1972

UNCHANNELIZED RIVER

STATION # 1 (8-10-72) (Nebr. Side)			STATION #8 (8-1-72)		
CILIATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE	% ABUNDANCE	ORGANISMS PER 1.0 ml
Strombilidium	100	7		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml
Chilomonas	91	168	Chilomonas	100	209
Euglena	6	12		0	0
Others	3	5	Others	0	0

TABLE 20
THE TWO MOST ABUNDANT CILIATE AND FLAGELLATE SPECIES
IN THE PLANKTON SAMPLES COLLECTED DURING

AUGUST, 1972

CHANNELIZED RIVER

STATION # 4 (8-18-72)			STATION # 6 (8-23-72)		
CILIATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	CILAITE	% ABUNDANCE	ORGANISMS PER 1.0 ml
Strombilidium	50	14		0	0
	0	0		0	0
Others	50	14	Others	0	0
FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE	% ABUNDANCE	ORGANISMS PER 1.0 ml
Peridinium	74	1,052	Chilomonas	100	83
Chilomonas	13	194		0	0
Others	13	193	Others	0	0

TABLE 21

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING SEPTEMBER, 1972

UNCHANNELIZED RIVER

STATION #1 (9-4-72)			STATION #2 (9-8-72)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Navicula	50	22.9×10^7	Navicula	25	6.6×10^8
Cymbella	42	19.1×10^7	Synedra	14	3.8×10^8
Diatoma	8	3.8×10^7	Fragilaria	12	3.2×10^8
*			Melosira	8	2.1×10^8
*			Achnanthes	7	1.7×10^8
Others	0	0	Others	34	9.0×10^8

CHANNELIZED RIVER

STATION #10 (9-29-72)			STATION #11 (9-15-72)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Synedra	29	7.6×10^8	Fragilaria	52	36.6×10^8
Cyclotella	29	7.6×10^8	Cyclotella	14	9.9×10^8
Navicula	12	3.1×10^8	Melosira	11	7.6×10^8
Fragilaria	12	3.1×10^8	Synedra	7	5.3×10^8
Surirella	12	3.1×10^8	Stephanodiscus	5	3.8×10^8
Others	6	1.5×10^8	Others	11	7.7×10^8

*Only 3 found in sample.

TABLE 22

THE FIVE MOST COMMON DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING SEPTEMBER, 1972

UNCHANNELIZED RIVER

GENERA	STATION #1 (9-4-72) (Nebr. side) % ABUNDANCE	CELLS PER 1.0 ml	GENERA	STATION #2 (9-8-72) % ABUNDANCE	CELLS PER 1.0 ml
Cyclotella	25	46	Cyclotella	24	62
Synedra	23	43	Synedra	23	60
Navicula	15	28	Navicula	15	38
Fragilaria	11	21	Stephanodiscus	9	25
Stephanodiscus	9	17	Fragilaria	7	17
Others	17	31	Others	22	56

CHANNELIZED RIVER

GENERA	STATION #10 (9-29-72) % ABUNDANCE	CELLS PER 1.0 ml.	GENERA	STATION #11 (9-15-72) % ABUNDANCE	CELLS PER 1.0 ml
Cyclotella	50	190	Cyclotella	41	529
Navicula	21	78	Stephanodiscus	18	225
Stephanodiscus	11	43	Melosira	17	215
*			Fragilaria	13	166
*			Synedra	5	69
Others	18	68	Others	6	78

* ...ted as dominant.

TABLE 23

THE TWO MOST ABUNDANT SPECIES OF CILIATES AND FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

SEPTEMBER, 1972

UNCHANNELIZED RIVER

	STATION #1 (9-4-72)			STATION #2 (9-8-72)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Nassula	100	1.5×10^7
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

	STATION #10 (9-29-73)			STATION #11 (9-15-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	6.1×10^9		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 24

THE TWO MOST ABUNDANT CILIATE AND FLAGELLATE SPECIES IN THE PLANKTON SAMPLES COLLECTED DURING

SEPTEMBER, 1972

UNCHANNELIZED RIVER

STATION #1 (9-4-72)			STATION #2 (9-8-72)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Strombilidium	75	12	Strombilidium	100	6
Codonella	12.5	2		0	0
Others	12.5	2	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml
Chilomonas	96	46	Chilomonas	100	273
Euglena	4	2		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

STATION #10 (9-29-72)			STATION #11 (9-15-72)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
	0	0	Codonella	77	10
	0	0	Strombilidium	23	3
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml
	0	0	Chilomonas	100	90
	0	0		0	0
Others	0	0	Others	0	0

TABLE 25

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING OCTOBER, 1972

UNCHANNELIZED RIVER

GENERA	STATION #14 (10-11-72) % ABUNDANCE	CELLS PER (m^2)	GENERA	* STATION # ( ) % ABUNDANCE	CELLS PER (m^2)
Fragilaria	17	13.4×10^8			
Synedra	16	12.5×10^8			
Melosira	14	11.6×10^8			
Navicula	12	9.5×10^8			
Cyclotella	8	6.7×10^8			
Others	33	26.5×10^8			

*Only one site in unchannelized river

CHANNELIZED RIVER

GENERA	STATION #10 (10-25-72) % ABUNDANCE	CELLS PER (m^2)	GENERA	STATION #13 (10-15-72) % ABUNDANCE	CELLS PER (m^2)
Synedra	19	3.9×10^9	Melosira	48	24.0×10^8
Cyclotella	18	3.8×10^9	Fragilaria	30	15.3×10^8
Melosira	14	2.9×10^9	Cyclotella	9	4.6×10^8
Navicula	10	2.1×10^9	Stephanodiscus	5	2.4×10^8
Stephanodiscus	8	1.7×10^9	Navicula	3	1.7×10^8
Others	31	6.5×10^9	Others	5	2.7×10^8

TABLE 26

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING OCTOBER, 1972

UNCHANNELIZED RIVER

GENERA	STATION #14 (10-11-72) % ABUNDANCE	CELLS PER 1.0 ml	GENERA	* STATION # ( ) % ABUNDANCE	CELLS PER 1.0 ml
Synedra	25	12			
Melosira	15	7			
Navicula	10	5			
Stephanodiscus	10	5			
**					
Others	40	19			

*Only one site in unchannelized river
**Only top 4 as dominant

CHANNELIZED RIVER

GENERA	STATION #10 (10-25-72) % ABUNDANCE	CELLS PER 1.0 ml.	GENERA	STATION #13 (10-15-72) % ABUNDANCE	CELLS PER 1.0 ml
Cyclotella	85	2,363	Cyclotella	48	1,370
Stephanodiscus	8	204	Fragilaria	20	559
Nitzschia	4	107	Melosira	18	498
Synedra	1	38	Stephanodiscus	5	131
Navicula	1	24	Synedra	3	93
Others	1	37	Others	6	165

TABLE 27

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

OCTOBER, 1972

UNCHANNELIZED RIVER

CILIATE SPECIES	STATION #14 (10-11-72) % OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	* STATION # ( ) % OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0			
	0	0			
Others	0	0	Others		
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0			
	0	0			
Others	0	0	Others		

*Only one site in unchannelized river.

CHANNELIZED RIVER

CILIATE SPECIES	STATION #10 (10-25-72) % OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	STATION #13 (10-15-72) % OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	3.1×10^8	Euglena	100	1.5×10^7
	0	0		0	0
Others	0	0	Others	0	0

TABLE 28

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

OCTOBER, 1972

UNCHANNELIZED RIVER

CILIATE SPECIES	STATION #14 (10-11-72) % OF ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE SPECIES	* STATION # ( ) % OF ABUNDANCE	ORGANISMS PER 1.0 ml
	0	0			
	0	0			
Others	0	0	Others		
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml
Chilomonas	94	31			
	0	0			
Others	6	2	Others		

*Only one site in unchannelized river.

CHANNELIZED RIVER

CILIATE SPECIES	STATION #10 (10-25-72) % OF ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE SPECIES	STATION #13 (10-15-72) % OF ABUNDANCE	ORGANISMS PER 1.0 ml
	0	0	Strombolidium	100	3
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml
Chilomonas	100	561	Chilomonas	100	106
	0	0		0	0
Others	0	0	Others	0	0

TABLE 29

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING NOVEMBER, 1972

UNCHANNELIZED RIVER

GENERA	STATION #1 (11-12-72) % OF ABUNDANCE	CELLS PER (m^2)	GENERA	STATION #2 (11-3-72) % OF ABUNDANCE	CELLS PER (m^2)
Cyclotella	35	16.8×10^7	Navicula	31	44.2×10^8
Synedra	29	13.7×10^7	Fragilaria	28	39.7×10^8
Navicula	10	4.6×10^7	Synedra	13	19.1×10^8
Fragilaria	10	4.6×10^7	Cyclotella	6	8.8×10^8
Nitaschia	7	3.1×10^7	Cymbella	5	6.5×10^8
Others	9	4.4×10^7	Others	17	24.2×10^8

* CHANNELIZED RIVER

GENERA	STATION # ( ) % OF ABUNDANCE	CELLS PER (m^2)	GENERA	STATION # ( ) % OF ABUNDANCE	CELLS PER (m^2)

*No channelized stations sampled.

TABLE 30

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING NOVEMBER, 1972

UNCHANNELIZED RIVER

STATION #1 (11-12-72)			STATION #2 (11-3-72)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml	GENERA	% ABUNDANCE	CELLS PER 1.0 ml
Cyclotella	61	111	Synedra	22	90
Synedra	20	36	Navicula	21	88
Fragilaria	5	10	Cyclotella	16	66
Navicula	4	7	Fragilaria	16	64
*			Nitzschia	5	22
Others	10	18	Others	20	81

*Only top 4 dominant

** CHANNELIZED RIVER

STATION # ( )			STATION # ( )		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml	GENERA	% ABUNDANCE	CELLS PER 1.0 ml

**No channelized stations sampled.

TABLE 31

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

NOVEMBER, 1972

UNCHANNELIZED RIVER

STATION #1 (11-12-72)			STATION #2 (11-3-72)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

* CHANNELIZED RIVER

*No channelized stations sampled.

TABLE 32

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

NOVEMBER, 1972

UNCHANNELIZED RIVER

CILIATE SPECIES	STATION #1 (11-12-72) % OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	STATION #2 (11-3-72) % OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Strombilidium	100	5		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	100	81	Chilomonas	89	42
	0	0	Euglena	11	5
Others	0	0	Others	0	0

* CHANNELIZED RIVER

*No channelized stations sampled.

TABLE 33

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING FEBRUARY, 1973

UNCHANNELIZED RIVER

GENERA	STATION #1 (2-3-73) % ABUNDANCE	CELLS PER (m^2)	GENERA	STATION #2 (2-3-73) % ABUNDANCE	CELLS PER (m^2)
Asterionella	71	49.6×10^7	Asterionella	85	25.9×10^7
Cyclotella	8	5.3×10^7	Surirella	5	1.5×10^7
Amphora	6	4.6×10^7	Amphora	5	1.5×10^7
Melosira	5	3.8×10^7	Synedra	5	1.5×10^7
Navicula	5	3.8×10^7	*	0	0
Others	5	3.8×10^7	Others	0	0

*Only 4 genera found.

** CHANNELIZED RIVER

**No channelized stations sampled.

TABLE 34

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING FEBRUARY, 1973

UNCHANNELIZED RIVER

GENERA	STATION #1 (2-3-73) % ABUNDANCE	CELLS PER 1.0 ml.	GENERA	STATION #15 (2-3-73) % ABUNDANCE	CELLS PER 1.0 ml.
Asterionella	100	3,010	Asterionella	99	1,633
*	0	0	Cymbella	1	2
*	0	0	*	0	0
*	0	0	*	0	0
*	0	0	*	0	0
Others	0	0	Others	0	0

*Only 1 genera found.

*Only 2 genera found.

** CHANNELIZED RIVER

**No channelized stations sampled.

TABLE 35

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING FEBRUARY, 1973

UNCHANNELIZED RIVER

CILIATE SPECIES	STATION #1 (2-3-73) % OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	STATION #15 (2-3-73) % OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Paramecium aurelia	100	1.5×10^7
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	6.1×10^7		0	0
	0	0		0	0
Others	0	0	Others	0	0

* CHANNELIZED RIVER

*No channelized stations sampled.

TABLE 36

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

FEBRUARY, 1973

UNCHANNELIZED RIVER

	STATION #1 (2-3-73)			STATION #15 (2-3-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	100	7		0	0
	0	0		0	0
Others	0	0	Others	0	0

* CHANNELIZED RIVER

*No channelized stations sampled.

TABLE 37

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING MARCH, 1973

* UNCHANNELIZED RIVER

*No unchannelized stations sampled because of low water.

CHANNELIZED RIVER

STATION #4 (3-30-73)			STATION #19 (3-31-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Melosira	28	11.4×10^8	Fragilaria	54	9.6×10^8
Fragilaria	22	9.2×10^8	Melosira	18	3.1×10^8
Navicula	13	5.3×10^8	Synedra	8	1.5×10^8
Synedra	13	5.3×10^8	Cyclotella	8	1.5×10^8
Stephanodiscus	9	3.8×10^8	Surirella	3	$.46 \times 10^8$
Others	15	6.2×10^8	Others	9	1.52×10^8

TABLE 38

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING MARCH, 1973

* UNCHANNELIZED RIVER

*No unchannelized stations sampled.

CHANNELIZED RIVER

STATION #4 (3-30-73)			STATION #19 (3-31-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml
Synedra	24	294	Cyclotella	24	623
Fragilaria	17	225	Fragilaria	17	450
Cyclotella	16	208	Asterionella	13	346
Stephanodiscus	9	121	Synedra	10	260
Melosira	9	121	Navicula	5	138
Others	25	329	Others	31	805

TABLE 39

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

MARCH, 1973

* UNCHANNELIZED RIVER

*No unchannelized stations sampled.

CHANNELIZED RIVER

	STATION #4 (3-30-73)			STATION #19 (3-31-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Vorticella sp.	50	3.1×10^7
	0	0	Paramecium aurelia	25	1.5×10^7
Others	0	0	Others	25	1.5×10^7
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	1.5×10^8		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 40

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

MARCH, 1973

* UNCHANNELIZED RIVER

*No unchannelized stations sampled.

CHANNELIZED RIVER

	STATION #4 (3-30-73)			STATION #19 (3-31-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
	0	0	Vorticella	25	17
	0	0	Paramecium aurelia	25	17
Others	0	0	Others	50	34
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml
Chilomonas	78	121		0	0
Euglena	22	35		0	0
Others	0	0	Others	0	0

TABLE 41

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING MARCH, 1973

SYNDER BEND OXBOW STATION #17 (3-9-73)			DeSOTO BEND OXBOW STATION #18 (3-9-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Synedra	20	19.8×10^7	Melosira	61	148.7×10^8
Fragilaria	17	16.8×10^7	Fragilaria	11	25.9×10^8
Gomphonoma	11	10.7×10^7	Synedra	6	15.3×10^8
Nitzschia	11	10.7×10^7	Navicula	6	14.5×10^8
Surirella	6	6.1×10^7	Nitzschia	3	6.9×10^8
Others	35	35.1×10^7	Others	13	30.7×10^8

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING MARCH, 1973

SYNDER BEND OXBOW STATION #17 (3-9-73)			DeSOTO BEND OXBOW STATION #18 (3-9-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml	GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Synedra	63	356	Synedra	42	446
Nitzschia	32	183	Navicula	33	343
Cyclotella	2	10	Nitzschia	13	142
Gomphonema	1	7	Cyclotella	3	35
Navicula	1	7	Melosira	3	31
Others	1	3	Others	6	61

TABLE 42

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

MARCH, 1973

SYNDER BEND OXBOW STATION #17 (3-9-73)			DeSOTO BEND OXBOW STATION #18 (3-9-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	4.6×10^7	Chilomonas	100	2.3×10^8
	0	0		0	0
Others	0	0	Others	0	0

TABLE 43

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

MARCH, 1973

SYNDER BEND OXBOW STATION #17 (3-9-73)			DeSOTO BEND OXBOW STATION #18 (3-9-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
	0	0	Vorticella	100	59
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	100	66	Chilomonas	90	581
	0	0	Dinobryon	10	62
Others	0	0	Others	0	0

TABLE 44

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING APRIL, 1973

UNCHANNELIZED RIVER

STATION #1 (4-18-73)			STATION #16 (4-20-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Melosira	28	7.6×10^7	Fragilaria	20	6.1×10^8
Synedra	22	6.1×10^7	Surirella	20	6.1×10^8
Asterionella	22	6.1×10^7	Gomphonema	17	5.3×10^8
Navicula	12	3.1×10^7	Synedra	15	4.6×10^8
Cyclotella	5	1.5×10^7	Nitzschia	11	3.1×10^8
Others	11	3.0×10^7	Others	17	5.3×10^8

CHANNELIZED RIVER

STATION #4 (4-14-73)			STATION #19 (4-14-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Synedra	27	9.2×10^8	Fragilaria	52	6.2×10^9
Cyclotella	21	6.9×10^8	Cyclotella	13	1.6×10^9
Stephanodiscus	11	3.8×10^8	Synedra	7	$.76 \times 10^9$
Fragilaria	11	3.8×10^8	Surirella	6	$.69 \times 10^9$
Surirella	9	3.1×10^8	Nitzschia	5	$.61 \times 10^9$
Others	21	6.8×10^8	Others	17	2.0×10^9

TABLE 45

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING APRIL, 1973

UNCHANNELIZED RIVER

STATION #1 (4-18-73)			STATION #16 (4-20-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Cyclotella	65	1,585	Fragilaria	34	1,211
Asterionella	28	697	Surirella	19	692
Fragilaria	2	40	Synedra	14	519
Synedra	1	35	Gomphonema	14	519
Surirella	1	24	Nitzschia	5	173
Others	3	71	Others	14	519

CHANNELIZED RIVER

STATION #4 (4-14-73)			STATION #19 (4-14-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Cyclotella	58	3,131	Cyclotella	68	4,602
Synedra	12	640	Fragilaria	10	692
Surirella	7	363	Asterionella	10	675
Gomphonema	6	329	Synedra	3	208
Stephanodiscus	5	242	Stephanodiscus	3	190
Others	12	657	Others	6	442

TABLE 46

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

APRIL, 1973

UNCHANNELIZED RIVER

	STATION #1 (4-18-73)			STATION #16 (4-20-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Strombilidium	100	7.6×10^7
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	3.1×10^7		0	0
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

	STATION #4 (4-14-73)			STATION #19 (4-14-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Strombilidium	100	7.6×10^7
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 47

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

APRIL, 1973

UNCHANNELIZED RIVER

	STATION #1 (4-18-73)			STATION #16 (4-20-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Strombilidium	100	36		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Dinobryon	50	64	Chilomonas	100	173
Chilomonas	27	35		0	0
Others	23	30	Others	0	0

CHANNELIZED RIVER

	STATION #4 (4-14-73)			STATION #19 (4-14-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Strombilidium	100	17	Strombilidium	100	52
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	100	121		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 48

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING APRIL, 1973

SYNDER BEND OXBOW STATION #17 (4-14-73)			DeSOTO BEND OXBOW STATION #18 (4-14-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Synedra	37	3.1×10^8	Synedra	72	1.7×10^{10}
Cyclotella	29	2.3×10^8	Melosira	17	$.40 \times 10^{10}$
Pinnularia	7	$.61 \times 10^8$	Navicula	3	$.08 \times 10^{10}$
Navicula	6	$.53 \times 10^8$	Fragilaria	2	$.05 \times 10^{10}$
Melosira	6	$.53 \times 10^8$	Nitzschia	1	$.03 \times 10^{10}$
Others	5	1.2×10^8	Others	5	$.11 \times 10^{10}$

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING APRIL, 1973

SYNDER BEND OXBOW STATION #17 (4-14-73)			DeSOTO BEND OXBOW STATION #18 (4-14-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml
Cyclotella	44	3,474	Synedra	84	26,441
Synedra	37	2,882	Melosira	13	3,937
Pinnularia	4	343	Nitzschia	1	484
Navicula	2	152	*		
Melosira	2	138	*		
Others	11	830	Others	2	574

TABLE 49

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

APRIL, 1973

SYNDER BEND OXBOW STATION #17 (4-14-73)			DeSOTO BEND OXBOW STATION #18 (4-14-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	89	1.9×10^8	Chilomonas	81	7.0×10^8
Euglena	7	$.15 \times 10^8$	Dinobryon	17	1.5×10^8
Others	4	$.08 \times 10^8$	Others	2	$.11 \times 10^8$

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

APRIL, 1973

SYNDER BEND OXBOW STATION #17 (4-14-73)			DeSOTO BEND OXBOW STATION #18 (4-14-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Paramecium aurelia	70	7	Strombilidium	60	21
Amphileptus	30	3	Nassula	40	14
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	48	249	Chilomonas	84	2,436
Cryptomonas	37	194	Dinobryon	12	339
Others	15	75	Others	4	111

TABLE 50

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING MAY, 1973

UNCHANNELIZED RIVER

STATION #1 (5-9-73)			STATION #16 (5-9-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Asterionella	77	1.4×10^9	Asterionella	36	2.8×10^9
Diatoma	10	$.18 \times 10^9$	Synedra	17	1.3×10^9
Synedra	3	$.05 \times 10^9$	Fragilaria	14	1.1×10^9
Fragilaria	2	$.04 \times 10^9$	Navicula	8	$.63 \times 10^9$
Cyclotella	2	$.04 \times 10^9$	Cyclotella	6	$.46 \times 10^9$
Others	6	$.10 \times 10^9$	Others	19	1.5×10^9

CHANNELIZED RIVER

STATION #4 (5-10-73)			STATION #19 (5-11-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Cyclotella	33	6.6×10^9	Cyclotella	51	4.8×10^9
Surirella	16	3.3×10^9	Synedra	10	$.99 \times 10^9$
Synedra	13	2.7×10^9	Melosira	9	$.84 \times 10^9$
Gomphonema	12	2.4×10^9	Fragilaria	6	$.61 \times 10^9$
Fragilaria	7	1.5×10^9	Navicula	6	$.53 \times 10^9$
Others	19	3.8×10^9	Others	18	1.7×10^9

TABLE 51

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING MAY, 1973

UNCHANNELIZED RIVER

STATION #1 (5-9-73)			STATION #16 (5-9-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Asterionella	96	4,744	Asterionella	82	5,052
Cyclotella	2	87	Fragilaria	8	510
Synedra	1	45	Synedra	3	190
*			Nitzschia	2	138
*			Cyclotella	2	130
Others	1	54	Others	3	192

CHANNELIZED RIVER

STATION #4 (5-10-73)			STATION #19 (5-11-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Fragilaria	23	848	Cyclotella	50	8,494
Synedra	19	727	Asterionella	30	5,121
Cyclotella	19	727	Fragilaria	6	986
Nitzschia	11	398	Synedra	6	969
Gomphonema	7	242	Nitzschia	2	346
Others	21	794	Others	6	1,036

TABLE 52

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

MAY, 1973

UNCHANNELIZED RIVER

STATION #1 (5-9-73)			STATION #16 (5-9-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Strombidium	100	4.6×10^7
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	6.1×10^7	Amphidinium	100	7.6×10^6
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

STATION #4 (5-10-73)			STATION #9 (5-11-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Chilomonas	100	1.5×10^8
	0	0		0	0
Others	0	0	Others	0	0

TABLE 53

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

MAY, 1973

UNCHANNELIZED RIVER

STATION #1 (5-9-73) CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	STATION #16 (5-9-73) CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Strombilidium	41	24		0	0
Codonella	41	24		0	0
Others	18	10	Others	0	0
FLAGELLATE SPECIES	**% OF ABUNDANCE**	**ORGANISMS PER 1.0 ml.**	**FLAGELLATE SPECIES**	**% OF ABUNDANCE**	**ORGANISMS PER 1.0 ml.**
Chilomonas	50	204	Dinobryon	79	1,176
Dinobryon	45	180	Chilomonas	20	303
Others	5	20	Others	1	9

CHANNELIZED RIVER

STATION #4 (5-10-73) CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	STATION #19 (5-11-73) CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
	0	0	Strombilidium	50	35
	0	0	Codonella	50	35
Others	0	0	Others	0	0
FLAGELLATE SPECIES	**% OF ABUNDANCE**	**ORGANISMS PER 1.0 . l.**	**FLAGELLATE SPECIES**	**% OF ABUNDANCE**	**ORGANISMS PER 1.0 ml.**
Chilomonas	100	190	Rhodomonas	61	1,246
	0	0	Dinobryon	22	450
Others	0	0	Others	17	346

TABLE 54

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING MAY, 1973

SYNDER BEND OXBOW STATION #17 (5-10-73)			DeSOTO BEND OXBOW STATION #18 (5-10-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Synedra	56	3.3×10^9	Synedra	38	6.5×10^{10}
Navicula	9	$.53 \times 10^9$	Melosira	30	5.1×10^{10}
Cyclotella	8	$.49 \times 10^9$	Fragilaria	18	3.1×10^{10}
Fragilaria	8	$.46 \times 10^9$	Navicula	6	1.1×10^{10}
Pinnularia	6	$.34 \times 10^9$	Nitzschia	2	$.31 \times 10^{10}$
Others	13	$.80 \times 10^9$	Others	6	$.94 \times 10^{10}$

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING MAY, 1973

SYNDER BEND OXBOW STATION #17 (5-10-73)			DeSOTO BEND OXBOW STATION #18 (5-10-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 m
Synedra	62	4,204	Melosira	95	2,585
Cyclotella	29	1,981	Synedra	2	50
Nitzschia	3	190	Cyclotella	1	28
Navicula	1	104	**		
*			**		
Others	5	348	Others	2	65

*Only 4 were dominant.

**Only 3 dominant species.

TABLE 55

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

MAY, 1973

SYNDER BEND OXBOW STATION #17 (5-10-73)			DeSOTO BEND OXBOW STATION #18 (5-10-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	100	3.8×10^8	Chilomonas	100	3.1×10^8
	0	0		0	0
Others	0	0	Others	0	0

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

MAY, 1973

SYNDER BEND OXBOW STATION #17 (5-10-73)			DeSOTO BEND OXBOW STATION #18 (5-10-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Strombilidium	56	78		0	0
Nassula	37	52		0	0
Others	7	9	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	55	2,370	Chilomonas	55	104
Dinobryon	32	1,367	Cryptomonas	32	59
Others	13	553	Others	13	25

TABLE 56

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING JUNE, 1973

UNCHANNELIZED RIVER

STATION #1 (6-12-73)			STATION #16 (6-12-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Fragilaria	25	2.4×10^8	Synedra	60	2.1×10^{10}
Navicula	17	1.6×10^8	Nitzschia	9	$.32 \times 10^{10}$
Synedra	17	1.6×10^8	Fragilaria	9	$.31 \times 10^{10}$
Asterionella	13	1.3×10^8	Navicula	6	$.22 \times 10^{10}$
Cyclotella	12	1.2×10^8	Surirella	4	$.13 \times 10^{10}$
Others	16	1.5×10^8	Others	12	$.41 \times 10^{10}$

CHANNELIZED RIVER

STATION #4 (6-6-73)			STATION #19 (6-4-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Synedra	29	5.6×10^9	Fragilaria	59	1.6×10^{10}
Melosira	20	4.0×10^9	Cyclotella	12	$.33 \times 10^{10}$
Cyclotella	17	3.4×10^9	Synedra	12	$.31 \times 10^{10}$
Navicula	12	2.3×10^9	Asterionella	4	$.10 \times 10^{10}$
Nitzschia	4	$.84 \times 10^9$	Navicula	2	$.06 \times 10^{10}$
Others	18	3.5×10^9	Others	11	$.30 \times 10^{10}$

TABLE 57

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING JUNE, 1973

UNCHANNELIZED RIVER

STATION #1 (6-12-73)			STATION #16 (6-12-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml
Asterionella	51	619	Synedra	62	7,543
Cyclotella	29	356	Navicula	15	1,920
Fragilaria	9	107	Fragilaria	9	1,107
Synedra	7	83	Nitzschia	5	606
Navicula	2	21	Surirella	2	225
Others	2	23	Others	7	849

CHANNELIZED RIVER

STATION #4 (6-6-73)			STATION #19 (6-4-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 ml
Synedra	29	2,111	Cyclotella	26	1,566
Cyclotella	21	1,540	Fragilaria	25	1,453
Melosira	14	1,021	Synedra	15	908
Navicula	9	675	Asterionella	13	787
Fragilaria	8	640	Melosira	5	277
Others	19	1,402	Others	16	918

TABLE 58

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

JUNE, 1973

UNCHANNELIZED RIVER

CILIATE SPECIES	STATION #1 (6-12-73) % OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	STATION #16 (6-12-73) % OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	**% OF ABUNDANCE**	**ORGANISMS PER (m^2)**	**FLAGELLATE SPECIES**	**% OF ABUNDANCE**	**ORGANISMS PER (m^2)**
Chilomonas	100	1.5×10^7		0	0
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

CILIATE SPECIES	STATION #4 (6-6-73) % OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	STATION #19 (6-4-73) % OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	**% OF ABUNDANCE**	**ORGANISMS PER (m^2)**	**FLAGELLATE SPECIES**	**% OF ABUNDANCE**	**ORGANISMS PER (m^2)**
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 59

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

JUNE, 1973

UNCHANNELIZED RIVER

	STATION #1 (6-12-73)			STATION #16 (6-12-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Strombilidium	62	28	Frontonia	100	17
Codonella	31	14		0	0
Others	7	3	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	97	547	Euglena	66	69
Gymnodinium	3	17	Chilomonas	34	35
Others	0	0	Others	0	0

CHANNELIZED RIVER

	STATION #4 (6-6-73)			STATION #19 (6-4-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
	0	0	Codonella	50	9
	0	0	Strombilidium	50	9
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	100	311	Chilomonas	100	199
	0	0		0	0
Others	0	0	Others	0	0

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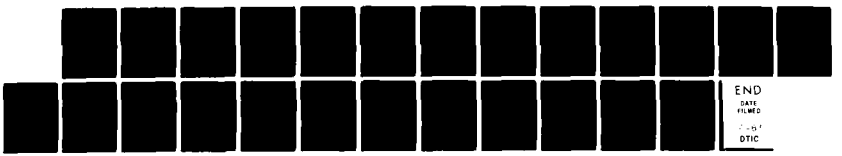

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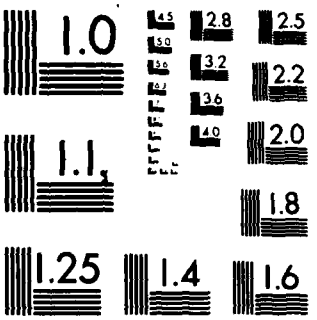

TABLE 60

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING JUNE, 1973

SYNDER BEND OXBOW STATION #17 (6-6-73)			DeSOTO BEND OXBOW STATION #18 (6-6-73)		
GENERA	% ABUNDANCE	CELLS PER (m^2)	GENERA	% ABUNDANCE	CELLS PER (m^2)
Fragilaria	27	1.6×10^9	Asterionella	37	1.9×10^9
Navicula	25	1.5×10^9	Fragilaria	31	1.6×10^9
Synedra	20	1.2×10^9	Navicula	9	$.45 \times 10^9$
Cyclotella	9	$.51 \times 10^9$	Synedra	8	$.40 \times 10^9$
Achnanthes	5	$.26 \times 10^9$	Gomphonema	5	$.27 \times 10^9$
Others	14	$.82 \times 10^9$	Others	10	$.52 \times 10^9$

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING JUNE, 1973

SYNDER BEND OXBOW STATION #17 (6-6-73)			DeSOTO BEND OXBOW STATION #18 (6-6-73)		
GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	GENERA	% ABUNDANCE	CELLS PER 1.0 m
Cyclotella	63	11,937	Asterionella	71	2,512
Synedra	17	3,235	Fragilaria	8	301
Navicula	7	1,349	Synedra	6	208
Fragilaria	5	934	Melosira	5	187
Achnanthes	2	433	Gomphonema	4	149
Others	6	1,056	Others	6	197

TABLE 61

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

JUNE, 1973

	SYNDER BEND OXBOW STATION #17 (6-6-73)			DeSOTO BEND OXBOW STATION #18 (6-6-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	50	7.6×10^6	Chilomonas	61	2.3×10^7
Dinobryon	50	7.6×10^6	Dinobryon	39	1.5×10^7
Others	0	0	Others	0	0

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

JUNE, 1973

	SYNDER BEND OXBOW STATION #17 (6-6-73)			DeSOTO BEND OXBOW STATION #18 (6-6-73)	
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Didinium	43	87		0	0
Oxytricha	18	35		0	0
Others	39	79	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER 1.0 ml.
Chilomonas	84	2,958	Chilomonas	77	270
Dinobryon	13	450	Dinobryon	23	80
Others	3	112	Others	0	0

TABLE 62

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING AUGUST, 1973

UNCHANNELIZED RIVER

GENERA	STATION #1 (8-4-73) % OF ABUNDANCE	CELLS PER (m^2)	GENERA	STATION #16 (8-4-73) % OF ABUNDANCE	CELLS PER (m^2)
Synedra	26	13.0×10^8	Synedra	54	45.6×10^9
Fragilaria	24	11.7×10^8	Fragilaria	17	13.7×10^9
Navicula	13	6.3×10^8	Navicula	12	9.9×10^9
Cyclotella	9	4.3×10^8	Surirella	4	3.2×10^9
*			Gomphonema	3	2.3×10^9
Others	28	14.2×10^8	Others	10	8.3×10^9

CHANNELIZED RIVER

GENERA	STATION #4 (8-5-73) % OF ABUNDANCE	CELLS PER (m^2)	GENERA	STATION #19 (8-14-73) % OF ABUNDANCE	CELLS PER (m^2)
Cyclotella	49	45.0×10^8	Cyclotella	38	25.2×10^7
Synedra	22	19.8×10^8	Navicula	23	15.3×10^7
Melosira	10	9.2×10^8	Fragilaria	15	9.9×10^7
Fragilaria	7	6.1×10^8	Synedra	10	6.9×10^7
Gomphonema	3	3.1×10^8	Melosira	6	4.6×10^7
Others	9	8.4×10^8	Others	6	4.5×10^7

*Only 4 top dominant species.

TABLE 63

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING AUGUST, 1973

UNCHANNELIZED RIVER

STATION #1 (8-4-73) GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	STATION #16 (8-4-73) GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Cyclotella	33	14	Synedra	73	3,408
Nitzschia	24	10	Fragilaria	13	640
Synedra	17	7	Navicula	8	398
Melosira	7	3	Nitzschia	2	87
*			Achnanthes	1	69
Others	19	8	Others	3	156

CHANNELIZED RIVER

STATION #4 (8-5-73) GENERA	% ABUNDANCE	CELLS PER 1.0 ml.	STATION #19 (8-14-73) GENERA	% ABUNDANCE	CELLS PER 1.0 ml.
Cyclotella	79	13,996	Cyclotella	61	1,754
Melosira	8	1,488	Synedra	16	446
Synedra	7	1,280	Melosira	10	277
Nitzschia	4	640	Fragilaria	8	235
Navicula	1	138	Navicula	2	66
Others	1	156	Others	3	95

*Only 4 dominant species.

TABLE 64

THE TWO MOST ABUNDANT SPECIES OF CILIATES AND FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

AUGUST, 1973

UNCHANNELIZED RIVER

STATION #1 (8-4-73)			STATION #16 (8-14-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

CHANNELIZED RIVER

STATION #4 (8-5-73)			STATION #19 (8-14-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
	0	0		0	0
	0	0		0	0
Others	0	0	Others	0	0

TABLE 65

THE TWO MOST ABUNDANT SPECIES OF CILIATES AND FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

AUGUST, 1973

UNCHANNELIZED RIVER

STATION #1 (8-4-73)			STATION #16 (8-4-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Codonella	82	9		0	0
Didinium	18	2		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	89	114	Euglena	100	52
Peridinium	5	7		0	0
Others	6	8	Others	0	0

CHANNELIZED RIVER

STATION #4 (8-5-73)			STATION #19 (8-14-73)		
CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Codonella	50	52	Codonella	60	42
Strombilidium	34	35	Strombidium	30	21
Others	16	17	Others	10	7
FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% OF ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	92	606	Chilomonas	72	55
Euglena	5	35	*		
Others	3	17	Others	28	21

*Only 1 dominant species.

TABLE 66

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE BENTHOS SAMPLES COLLECTED DURING

AUGUST, 1973

Synder Bend Oxbow STATION #17 (8-13-73)			DeSOTO BEND OXBOW STATION #18 (8-13-73		
GENERA	%ABUNDANCE	CELLS PER (m^2)	GENERA	%ABUDNDANCE	CELLS PER (m^2)
Fragilaria	37	9.1×10^8	Melosira	38	1.6×10^9
Achnanthes	34	8.4×10^8	Fragilaria	27	1.1×10^9
Navicula	11	2.7×10^8	Synedra	18	$.76 \times 10^9$
Cyclotella	11	2.7×10^8	Navicula	8	$.34 \times 10^9$
*			Cyclotella	6	$.26 \times 10^9$
Others	7	1.7×10^8	Others	3	$.12 \times 10^9$

*Only 4 dominant genera

TABLE 67

THE FIVE MOST ABUNDANT DIATOM GENERA IN THE PLANKTON SAMPLES COLLECTED DURING

AUGUST, 1973

Synder Bend Oxbow

STATION #17
(8-13-73)

GENERA	%ABUNDANCE	CELLS PER (m^2)
Cyclotella	33	718
Achnanthes	27	588
Synedra	11	242
Fragilaria	9	216
Navicula	7	147
Others	13	278

DeSOTO BEND OXBOW

STATION #18
(8-13-73

GENERA	&ABUNDANCE	CELLS PER (m^2)
Cyclotella	33	581
Synedra	30	536
Melosira	27	474
Fragilaria	6	104
Nitzschia	2	28
Others	2	41

TABLE 68

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE BENTHOS SAMPLES COLLECTED DURING

AUGUST, 1973

SYNDER BEND OXBOW STATION #17 (8-13-73)			DeSOTO BEND OXBOW STATION #18 (8-13-73)		
CILIATE SPECIES	% ABUNDANCE	ORGANISMS PER (m^2)	CILIATE SPECIES	% ABUNDANCE	ORGANISMS PER (m^2)
	0	0	Spirostomum	100	1.5×10^7
	0	0		0	0
Others	0	0	Others	0	0
FLAGELLATE SPECIES	% ABUNDANCE	ORGANISMS PER (m^2)	FLAGELLATE SPECIES	% ABUNDANCE	ORGANISMS PER (m^2)
Chilomonas	80	3.1×10^7	Chilomonas	100	4.6×10^7
Euglena	20	$.76 \times 10^7$		0	0
Others	0	0	Others	0	0

TABLE 69

THE TWO MOST ABUNDANT SPECIES OF CILIATES & FLAGELLATES IN THE PLANKTON SAMPLES COLLECTED DURING

AUGUST, 1973

SYNDER BEND OXBOW STATION #17 (8-13-73)			DeSOTO BEND OXBOW STATION #18 (8-13-73)		
CILIATE SPECIES	% ABUNDANCE	ORGANISMS PER 1.0 ml	CILIATE SPECIES	% ABUNDANCE	ORGANISMS PER 1.0 ml
Strombidium	38	35	Vorticella	50	62
Codonella	28	26	Codonella	17	21
Others	34	31	Others	33	40
FLAGELLATE SPECIES	% ABUNDANCE	ORGANISMS PER 1.0 ml	FLAGELLATE SPECIES	% ABUNDANCE	ORGANISMS PER 1.0 ml
Chilomonas	49	1,090	Chilomonas	79	201
Euglena	15	329	Peridinium	11	28
Others	36	791	Others	10	26

SUMMARY AND CONCLUSIONS

Between July, 1972 and August, 1973, microbenthic and planktonic organisms were collected at monthly intervals, except during the months of December, 1972 and January, 1973 because of the cold weather and adverse sampling conditions, and July, 1973 in which time was spent identifying prepared slides. Sampling stations were randomly chosen among the various types of habitat available in the unchannelized portion of the Missouri River between Yankton, South Dakota and Ponca, Nebraska and in the channelized portion of the river from Ponca, Nebraska to Rulo, Nebraska. Between March, 1973 and August, 1973, these organisms were collected at Synder Bend Oxbow and DeSoto Bend Oxbow lakes. Water quality parameters were also analyzed during these periods to establish the roles that nutrient availability, temperature, dissolved oxygen concentration, and turbidity played in the abundance and diversification of these planktonic and microbenthic organisms. The findings of this investigation may be summarized as follows:

1. The turbidity of the water in the Missouri River was found to be considerably less in the unchannelized river than in the channelized river. The higher speed and turbidity of the channelized river is related to channelization with the result of the narrower average width of the main channel in the channelized portion of the river. These two related factors are responsible for the channelized portion of the Missouri River demonstrating a higher capacity for silt and organic matter resulting from an increased turbulence.

2. The pH, or hydrogen-ion concentration of the Missouri River did not vary enough to exclude or restrict most organisms from inhabiting its waters. The pH recorded from the water in the unchannelized river was somewhat more restricted in range than the water from the channelized river. The water in the unchannelized river is greatly influenced by the discharge from Gavins Point Dam and would be affected for some distance below the dam by the water conditions present above the dam. The less restricted pH range of the water in the channelized portion of the river may be due to the larger number of populated communities along the banks of the Missouri River in the channelized section of the river. The greater number of tributary streams whose drainage from agricultural and feedlot areas influence the quality of the water in the Missouri River and provide an increased variation in pH.

3. Phosphorus and nitrogen, which are usually found as dissolved salts (PO_4 and NO_3 respectively) are two very important chemical nutrients required by microbenthic and planktonic organism in an aquatic ecosystem. The unchannelized river had a higher concentration of NO_3 than did the channelized river. The PO_4 concentration was higher in the channelized river than in the unchannelized river. The importance of the nitrogen-phosphorus ratio as a prime limiting factor for aquatic communities was reported by Hustedt (1939). The nitrogen-phosphorus ratio is important as the populations of aquatic communities to some extent are regulated by the concentrations of these two nutrients in the environment.

4. The air and water temperature were found to have a direct effect upon the concentration of dissolved oxygen in the Missouri River. The high current velocity and turbidity of the Missouri River also have some influence as to the concentration of dissolved oxygen in the water, Allan (1920). The dissolved oxygen concentration in all of the sampling stations from July, 1972 to August, 1973 was found to be of sufficient concentration to support most forms of aquatic life. In most instances, the dissolved oxygen concentration was near the saturation point and was caused by the high turbidity of the water, the air temperature, and the water velocity. These factors allow the water to become saturated with oxygen and thus permitting aquatic organisms to exist. Generally, as the water temperature decreased the dissolved oxygen concentration increased due to the ability of colder water to hold more oxygen.

5. The most common diatom genera in the benthos of the unchannelized river during the summer and fall months were Fragilaria and Navicula. The genera Cyclotella and Synedra were the most abundant diatoms during the summer and fall months in the channelized portion of the river. The winter and spring months were characterized by having the diatom genus Asterionella as the most common type in the benthos of the unchannelized river during the spring and winter months.

   The most common planktonic diatom genera during the summer and fall months in the unchannelized river were Cyclotella, Synedra, and Navicula. In the channelized river the most abundant genera were Cyclotella, Melosira, and Synedra. During the winter and spring months the most abundant diatom in the plankton of the unchannelized river was the genus Asterionella. In the channelized river the most abundant diatom genera of the winter and spring months were Cyclotella and Synedra. These

findings for the diatom genera in the Missouri River were similar to those reported by Williams (1963). He reported the genus Asterionella as the most common diatom in the benthos and plankton of the unchannelized river during the spring months and the genus Stephanodiscus as the most common type in the channelized river during the fall months. According to Williams (1963), the genus Stephanodiscus was the most common diatom during the spring months and the genus Melosira was the most common autumn diatom in the channelized portion of the river.

6. The most abundant flagellated protozoan found in the benthos and plankton of both the unchannelized and channelized portions of the river was species of the genus Chilomonas. The most common ciliated protozoan in the benthos and plankton of both sections of the river were species of the genera Strombilidium, Vorticella, and the ciliate Paramecium aurelia.

7. The metozoan forms were not found in large numbers at any time or at any sampling station during the project from July, 1972 to August, 1973. The most common metazoan form in the benthos and plankton of both the channelized and unchannelized portions of the river were members belonging to the Rotifera grouping. Although the numbers of metazoans found was not large, their importance in biomass is significant as they fill an important link in the aquatic food chain. These metazoan forms are a source of food for many species of fish fry (Morris; 1963, 1965).

8. The three major groups of macro-benthic organisms in the channelized and unchannelized river were members of the Oligochaeta, Ephemeroptera, and Trichoptera groups. The average standing crop of the main stream macro-benthos was greater in the unchannelized section of the Missouri River than in the channelized section (Morris, 1968).

Two major groups of organisms occurred in the drift as reported by Morris (1965 and 1968). Crustacea were the most abundant group in the unchannelized river and the Insecta were the most abundant group in the channelized river. The standing crop of drift was much larger in the unchannelized river than in the channelized portion of the river (Morris, 1968).

Morris (1965 and 1968) and Modde (1973) report the importance of these macro organisms, (which feed on the microbenthic and planktonic organisms) as important sources of food for several species of fish. The larger standing crops of the benthos and drift in the unchannelized river is due to larger and more diversified habitats available to these organisms, as well as the factors of lower water velocity and less turbidity.

9. Beginning in March 1973 Synder Bend and DeSoto Bend Oxbow lakes were sampled at a monthly basis through August 1973, except for the month of July. The findings from these two sampling stations provide some indication as to the diversity and abundance in this type of habitat as they signify some of the similarities and differences between lentic and lotic bodies of water. The most common diatom genera in the benthos at Synder Bend Oxbow were Synedra and Fragilaria, whereas; the planktonic forms were the diatom genera Synedra and Cyclotella. DeSoto Bend Oxbow had the diatom genera Melosira and Fragilaria as the most common in the benthos and the genus Synedra as the most common diatom in the plankton.

The most common flagellated protozoan in the benthos and plankton at Synder Bend and DeSoto Bend Oxbow lakes were species of the genus Chilomonas. The most abundant ciliated protozoan in the plankton at Synder Bend Oxbow were species of the genera Strombilidium, Strombidium, Didinium, and the ciliate Paramecium aurelia. In DeSoto Bend Oxbow the most common ciliate protozoan in the plankton were species of the genera Vorticella, Strombilidium and Nassula. The ciliated protozoans were not found in any great numbers in the benthos at either Synder Bend or DeSoto Bend Oxbows. Generally, the most common protozoan found in both of these oxbow lakes were species of the flagellated genus Chilomonas.

The metazoan forms were not present in any large numbers throughout the sampling at both Synder Bend and DeSoto Bend Oxbows. These results were similar to those found for the metazoan forms in the channelized and unchannelized portions of the Missouri River. However, their importance is not in total numbers but in the total biomass, as they play an important role in the overall food chain of an aquatic ecosystem. The type of methods used in sampling and in slide preparation tend to exclude many of these organisms on the permanent slides thus, their

true populations may be somewhat larger. The metazoan forms recorded for Synder Bend and DeSoto Bend Oxbows were forms of the Nematoda and Rotifera groups.

The two oxbow lakes were found to be very productive habitats for aquatic organisms in terms of abundance and diversity. The oxbow lakes had a larger diversity of protozoans than were found in either the channelized or unchannelized sections of the Missouri River. This difference is due to the absence of the current and less turbidity as limiting factors in the ecosystem of the oxbow lakes. A one year study such as this yields a large amount of information concerning these different habitats. However, the many variable environmental factors present during this study might have influenced to some extent the results that were derived during this period in which the project was undertaken. Throughout much of the study the water level in the Missouri River was in a state of fluctuation which greatly effects the chemical and physical aspects and the habitat available for many forms of aquatic life. Synder Bend Oxbow is governed by the water level in the Missouri River as to the water level which will be present in the oxbow lake. The data collected from Synder Bend was probably influenced to a great extent by the low water level during the spring and summer of 1973.

It is suggested that further studies be conducted on the Missouri River and in the oxbow lakes, especially on the protozoan forms. Very little work has been done by researchers as to the diversity and abundance of the protozoans and to their important role they play in this type of ecosystem in the overall food chain. When better sampling techniques have evolved to include the fragile members belonging to the protozoa and other micro-benthic groups, their importance will be better documented.

BIBLIOGRAPHY

British Phycological Journal, Vol. 7, No. 1, March, 1972. Academic Press, London and New York. Pg. 37-44.

British Phycological Journal, Vol. 7, No. 2, July, 1972. Academic Press, London and New York. Pg. 213-220, 255-270, and 277-278.

Clapham, W. B., Natural Ecosystems, 1973. The Macmillan Company, New York and Collier-Macmillan Limited, London. Pg. 142-144.

Clesceri, Nicholas L. and Sherman L. Williams, Diatom Population Changes in Lake George, N. Y., 1972. Rensselaer Polytechnic Institute, Troy, New York.

Cummins, K. W., C. A. Tryon, Jr., and R. T. Hartman, Organic-Substrate Relationships in Streams, 1966. Edwards Brothers Inc., Ann Arbor, Michigan.

Dodd, John D., The Ecology of Diatoms in Hardwater Habitats, 1971. Water Pollution Control Research Series Project # 18050DIE. U. S. Environmental Protection Agency.

Ford, Richard F. and William E. Hazen, Readings in Aquatic Ecology, 1972. W. B. Sanders, Philadelphia, London, Toronto. Pg. 141-147.

Golterman, H. L., Methods for Chemical Analysis of Fresh Waters, 1969. International Biological Programme Handbook No. 8. Blackwell Scientific Publications, Oxford and Edinburgh, England. Pg. 133 and 137.

Hansen, Edward A., Sediment in a Michigan Trout Stream: Its Source, Movement and Some Effects on Fish Habitat, 1971. Forest Service, U. S. Department of Agriculture. St. Paul, Minnesota.

Jackson, Daniel F. and Bettina B. Jackson, Algae and Environmental Problems, 1971. Ward's National Science Establishment, Inc., Rochester, New York.

Jahn, T. L., How to Know the Protozoa, 1949. Wm. C. Brown Company, Dubuque, Iowa.

Knutson, Keith M., Plankton Ecology of Lake Ashtabula Reservoir Valley City, North Dakota, 1970. North Dakota State University Library. Fargo, North Dakota.

Kudo, Richard R., Protozoology, 1971. Fifth Edition, Second Printing. Charles C. Thomas Springfield, Illinois.

Lanza, Guy R. and John Cairns, Jr., Physio-Morphological Effects of Abrupt Thermal Stress on Diatoms, 1972. Trans. Amer. Microscopic Society, Vol. 91(3). 276-295.

Larimore, R. Weldon, Daily and Seasonal Drift of Organisms in a Warmwater Stream, 1972. University of Illinois Water Resources Center, Urbana, Illinois.

Lundin, Francis C., and Luther S. West, The Free-Living Protozoa of the Upper Peninsula of Michigan, 1963. The Northern Michigan College Press, Marquette, Michigan.

Mackenthum, Kenneth M., The Practice of Water Pollution Biology, 1969. U. S. Department of the Interior, Federal Water Pollution Control Administration, Washington, D. C.

Manwell, Reginald D., Introduction to Protozoology, 1968. Dover Publications, Inc., New York.

McDonnell, Archie J., and S. Douglas Hall, Effect of Environmental Factors on Benthic Oxygen Uptake, 1969. Journal Water Pollution Control Federation, Washington, D. C.

Morris, Larry A., Stream Inventory and Studies, 1963. Job Completion Report, Nebraska.

Morris, Larry A., Stream Inventory and Studies, 1965. Job Completion Report, Nebraska.

Morris, Larry A., Ralph N. Langemeier, Thomas R. Russell and Arthur Witt, Jr., Effects of Main Stem Impoundments and Channelization Upon the Limnology of the Missouri River, Nebraska, 1968. Reprinted from Transactions of the American Fisheries Society, Vol. 97 (4): 380-388.

Modde, Timothy C., Food Selectivity of the Shovelnose Sturgeon, Scaphirynchus Platorhynchus, in the Missouri River, 1973. Department of Biology, The University of South Dakota, Vermillion, South Dakota.

Nauwerck, Urval Arnold, and Bilder Staffan Holmgren, Phytoplankton, 1972. Limnological Institute, Uppsala, Sweden.

Needham, James G., and Paul R. Needham, A Guide to the Study of Fresh-Water Biology, 1962. Fifth Edition, Holden-Day Inc., San Francisco.

Obeng-Asamoa, E. K., and B. C. Parker, Seasonal Changes in Phytoplankton and Water Chemistry of Mountain Lake, Virginia, 1972. Trans. Amer. Micros. Soc., 91 (3): 363-380.

Odum, Eugene P., Fundamentals of Ecology, 1971. Third Edition, W. B. Saunders Company, Philadelphia, London, Toronto.

Palmer, C. Mervin, Algae in Water Supplies: An Illustrated Manual on the Identification, Significance, and Control of Algae in Water Supplies. U. S. Department of Health, Education, and Welfare. Public Health Service, Division of Water Supply and Pollution Control, Washington, D. C.

Patrick, Ruth, and Charles W. Reimer, The Diatoms of the United States Exclusive of Alaska and Hawaii, 1966. Livingston Publishing Company Vol. 1.

Patrick, Ruth, Benthic Stream Communities, 1970. American Scientist, Vol. 58 (5): 546-549.

Prescott, G. W., Algae of the Western Great Lakes Area, 1962. Wm. C. Brown Company, Dubuque, Iowa.

Prescott, G. W., How to Know the Fresh-Water Algae, 1964. Wm. C. Brown Company, Dubuque, Iowa.

Sherman, Barbara J. and Harry K. Phinney, Benthic Algae Communities of the Metolius River, 1971. Journal of Phycology, Vol. 7(4).

Smith, Gilbert M., The Fresh-Water Algae of the United States, 1950. McGraw-Hill Book Company, Inc., New York, Toronto, and London.

Squires, Lorin E., Samuel R. Rushforth, and Carol J. Endsley, An Ecological Survey of the Algae of Huntington Canyon, Utah, 1973. Brigham Young, University Science Bulletin, Biological Series, Vol. 18(2).

Standard Methods for the Examination of Water and Wastewater, 1966. The American Public Health Association, the American Water Works Association, and the Water Pollution Control Federation, Twelfth Edition, Second Printing.

Tiffany, Lewis Hanford and Max Edwin Britton, The Algae of Illinois, 1952. The University of Chicago Press, Chicago, Illinois.

Tiffany, Lewis Hanford, Algae, the Grass of Many Waters, 1958. Charles C. Thomas, Springfield, Illinois.

Tryon, C. A. Jr., and M. A. Shapiro, Man and the Waters of the Upper Ohio Basin, 1956. Edwards Brothers, Inc., Ann Arbor, Michigan.

Tryon, C. A. Jr., and R. T. Hartman, The Ecology of Algae, 1959. Edwards Brothers, Inc., Ann Arbor, Michigan.

Tryon, C. A. Jr., R. T. Hartman and K. W. Cummins, Studies on the Aquatic Ecology of the Upper Ohio River System, 1965. Edwards Brothers, Inc., Ann Arbor, Michigan.

Ward, Henry B., and George C. Whipple, Fresh-Water Biology, 1966. Second Edition, Fourth Printing. John Wiley & Sons, Inc., New York and London.

Weber, Cornelius I., A Guide to the Common Diatoms at Water Pollution Surveillance System Stations, 1966. U. S. Department of the Interior, Federal Water Pollution Control Administration, Water Pollution Surveillance, Cincinnati, Ohio.

Weber, Cornelius I., and Ronald L. Raschke, Use of a Floating Periphyton Sampler for Water Pollution Surveillance, 1970. Federal Water Pollution Control Administration, Division of Water Quality Research, Analytical Quality Control Laboratory, Cincinnati, Ohio.

Weiss, Charles M., Thomas W. Yocum, and Jennifer E. Minogue, Further Characterization of the Water Quality of the New Hope and Lower Haw Rivers Including Benthic Macroinvertebrate Diversity and Trace Metal Analyses, 1972. Water Resources Research Institute of the University of North Carolina, North Carolina State University, Raleigh, North Carolina.

Whitford, L. A., and G. J. Schumacher, A Manual of the Fresh-Water Algae in North Carolina, 1969. North Carolina Agricultural Experiment Station Technical Bulletin No. 188.

Williams, Louis G., Plankton Diatom Species Biomasses and the Quality of American Rivers and the Great Lakes, 1972. Ecology Vol. 53(6).

Wood, R. D., and John Lutes, Guide to the Phytoplankton of Narragansett Bay, Rhode Island, 1968. Kingston Press, West Kingston, Rhode Island.

APPENDIX

Formula for Planktonic Algae Fixative Stain

This fixative is also referred to as IKI because of the chemicals used to make the fixative stain. Listed below are the chemicals and the steps showing how to make IKI fixative stain, Iodine, Potassium - Iodine, Iodide

1. Measure out 200ml of deionized water in a graduated cylinder and pour into a 500ml flask.

2. Weigh out 10 grams of Iodine.

3. Weigh out 20 grams of KI (Potassium - Iodide)

4. Mix the Iodine and Potassium - Iodide together and add to the flask containing the deionized water.

5. Add 20ml of Glacial Acetic Acid to the flask containing the deionized water, Iodine, and Potassium - Iodide. Mix the contents of the flask thoroughly with a glass stirring rod.

This mixture should form a dark orange-red stain. This fixative stain is good for fixing and staining diatoms as it demonstrates the presence of starch ($C_6H_{10}O_5$), (Prescott, 1964). Surface sample vials contained 0.3 ml of IKI stain before the 30 ml of water sample was added. The fixative should only be added to the sample collecting vials just prior to embarking on a field expedition because the 0.3 ml of IKI may dehydrate before the water sample can be added.

Formula for Schaudinn's Fixative

This fixative is the one most commonly used fixative for protozoan organisms. The steps for preparing this stain are listed below.

1. Take Mercuric Chloride (saturated aqueous solution) two parts or 66 ml and pour it into a large graduated cylinder. The Mercuric Chloride (saturated aqueous solution) is made by adding powdered Mercuric Chloride to deionized water and stir vigorously with a glass stirring rod to mix.

2. Add 1 part or 33 ml of Ethyl Alcohol (95%) to the graduated cylinder containing the Mercuric Chloride. Mix the contents of the graduated cylinder by stirring with a glass stirring rod to complete the formula.

To prepare the 30 ml plastic sample vials before going into the field, pipette 10 ml of the fixative and pour it into the plastic vial. Add 1 to 2 drops of Glacial Acetic Acid to the vial. The Glacial Acetic Acid should be added to the sample vials just prior to going into the field to prevent deterioration of the fixative.

Dissolved Oxygen--Titration Method Using PAO

A new reagent for the titration of Iodine in the Standard Winkler Method (Alsterberg modification) has been found which, in contrast to the Sodium Thiosulfate solution, is completely stable. The new reagent, Phenylarsene Oxide (PAO), performs identically with Sodium Thiosulfate. Therefore, it is not necessary to standardize the solution used to titrate dissolved oxygen. It is also necessary to adjust the calculations used in the test because of the deterioration of the Sodium Thiosulfate solution which has been universally used up to this time.

The step by step procedure for the determination of dissolved oxygen is outlined here.

1. Fill a standard 300 ml BOD bottle with the water to be tested by allowing the water to overflow the bottle for 2 or 3 minutes. Be certain there are no air bubbles present in the bottle. Add the contents of one Manganous Sulfate Powder Pillow (or 2 ml of Manganous Sulfate Solution).

2. Add the contents of one Alkaline Iodide-Azide Powder Pillow (or 2 ml of Alkaline Iodide-Sodium Azide Solution) to the BOD bottle.

3. Restopper the bottle in a manner so as to exclude all air bubbles. Shake to dissolve the powder and mix the floc that is formed. Allow the floc to settle about one-half the way down the bottle.

4. Clip open one pillow of Sulfamic Acid (or add 2 mls of concentrated Sulfuric Acid); remove the stopper and add to the sample bottle. Restopper, and shake to mix. The floc will dissolve and a yellow color will develop if oxygen was present.

5. Fill a 500 ml graduate to the 200 ml mark with the solution from the BOD bottle. Pour this into a 300 ml erlenmeyer flask.

6. Using the Standard PAO (Phenylarsene Oxide) solution, titrate the sample until it is pale yellow.

7. Add 2 ml of Starch Indicator Solution. A blue color will be formed.

8. Continue the titration until the blue color just disappears.

9. The p.p.m. (parts per million) of Dissolved Oxygen is equal to the number of mls. of PAO used.

A hypothetical example is outlined below to explain how the method used for determining the total number of organisms per unit area of benthos habitat can be followed.

1. Suppose we had used 0.1 ml of the original cored benthos sample and had counted 25 organisms of a particular species in the two transent counts. According to part (A) of the formula, we multiply 25 X 17.3 (two transect count multiplication factor). The result is 432.5 organisms on the total millipore slide. This is the number of organisms in 0.1 ml of cored sample.

2. Since we are looking for the number of organisms in 1 ml of the sample, we must multiply 432.5 organisms/0.1 ml X 10 to give us the number of organisms/1 ml. The result is 4,325 organisms/1 ml.

3. The 10 ml of cored sample was diluted by 1/2 in the sample vial because of the 10 ml of Schaudinn's Fixative. Thus, we must multiply the number of organisms/1 ml in step # 2 times a factor of two.
4,325 organisms/1 ml X 2 = 8,650 organisms/1 ml.

4. Since the total cored sample contained 200 ml of benthos mud and river water we must multiply the number of organisms/1 ml times 200 to give us the number of organisms in the 200 ml of cored benthos sample.

Thus, 8,650 organisms/1 ml X 200 = 1,730,000 organisms/200 ml of cored benthos sample.

5. We can calculate the number of organisms per square meter (m^2) in one of two ways.

A. Take the result of step #4 and divide it by 9.0746 cm^2.

$$\frac{1,730,000 \text{ organisms}}{9.0746 \text{ cm}^2 \text{ (area of core sampler)}} = 190,642.0117 \text{ organisms/cm}^2$$

We now take 190,642.0117 organisms/cm^2 X 10,000 cm^2 = 1,906,420,117. This is the number of organisms per square meter (m^2) of benthos habitat. B. The second method is to take the result of step #4 times 1,102. Thus, 1,730,000 X 1,102 = 1,906,460,000 or 1.9 X 10^9 which also is the number of organisms per square meter (m^2) of benthos habitat.

Because of its simplicity, the second method, method (B), was used most of the time in this project. The difference between the results of method (A) and (B) is not significant when such large numbers were involved. The numbers 9.0746 and 1,101.97694 have been rounded to 9.07 and 1,102 respectively. Because of the large numbers or organisms found in the benthos, the rounding of these two numbers does not significantly affect the total numbers of organisms found at any particular sampling station.

A hypothetical example is outlined below to explain how the formula for the determination of the total number of planktonic organisms per 1 ml of surface water can be followed.

(A) Step # 1

Suppose we had a total of 20 of a particular type of organism counted in the two transects. If we had used 5 ml of the water sample in the filtering process we would have to divide the number of organisms counted by a factor of 5 to give us the number of organisms in 1 ml. Thus, $\frac{20 \text{ organisms}}{5 \text{ ml}}$ = 4 organisms/1 ml.

Step # 2

We multiply the number of organisms in the two transect counts/1 ml of surface water times 17.3. This will give us the total number of organisms in 1 ml of water sample. Thus, 4 organisms/ 1 ml X 17.3 (multiplication factor) = 69.2 or 69 organisms/ 1 ml of water sample of a particular organism.

(B) Step # 1

Suppose we had a total of 20 of a particular type of organism counted in the two transects. If we had used only 0.5 ml of water sample in the filtering process, than we must multiply the transect counts by a factor of 2, to arrive at the number of organisms/ 1 ml. Thus, 20 organisms X 2 = 40 organisms/ 1 ml of surface water.

Step # 2

Multiply the number of organisms in the the transect counts times 17.3, which is the multiplication factor used for two transect counts, to give us the total number of organisms per 1 ml of surface water sample. Thus, 40 organisms X 17.3 = 682 organisms of a particular species in 1 ml of surface water sample.

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